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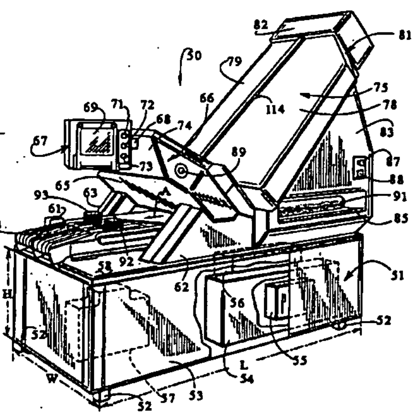
(54) **Slicing machine and method for slicing two or more food loaves**

(57) A high speed slicing machine (50) feeds one, two, or more food loaves (91) along parallel loaf paths into a slicing station (66) for slicing by one cyclically driven knife blade; the slices are stacked or shingled in groups (92,93) on a receiving conveyor (64) located below the slicing station (66). Independent loaf feed drives are provided; slices cut from one loaf may be thicker than slices from the other. The machine may combine manual and automated food loaf loading mechanisms that share a central barrier used only during loading. The automated loaf loading mechanism (75) has a sweep to push loaves onto the loaf paths. There are grippers each loaf path; each has a loaf feed drive that impels the gripper toward the slicing station and then moves it back to a home position. Each loaf feed drive also includes two "short" conveyors.

FIG. 1



EP 0 713 753 A2

Description

Background of the Invention

Many different kinds of food loaves are produced; they come in a wide variety of shapes and sizes. There are meat loaves made from various different meats, including ham, pork, beef, lamb, turkey, fish, and even meats not usually mentioned. The meat in the food loaf may be in large pieces or may be thoroughly comminuted. These meat loaves come in different shapes (round, square, rectangular, oval, etc.) and in different lengths up to four feet (122 cm) or even longer. The cross-sectional sizes of the loaves are quite different; the maximum transverse dimension may be as small as 1.5 inches (4 cm) or as large as ten inches (25.4 cm). Loaves of cheese or other foods come in the same great ranges as to composition, shape, length, and transverse size.

Many of these food loaves meet a common fate; they are sliced, the slices are grouped in accordance with a particular weight requirement, and the groups of slices are packaged and sold at retail. The number of slices in a group may vary, depending on the size and consistency of the food loaf and even on the whim of the producer, the wholesaler, or the retailer. For some products, neatly aligned stacked slice groups are preferred. For others, the groups are shingled so that a purchaser can see a part of every slice through a transparent package. And when it comes to bacon or other food products of variable shape, the problems do not just increase; they literally multiply.

A variety of different known slicing machines have been used to slice food loaves. They range from small, manually fed slices used in butcher shops and in retail establishments to large, high speed slicers usually employed in meat processing plants. The present invention is directed to a high speed slicing machine used in a meat processing plant and to a method of operation for the machine.

Some known high speed food loaf slicing machines have provided for slicing two food loaves simultaneously with a single, cyclically driven knife blade. Other prior high speed slicing machines, including that shown in S. Lindee et al. U. S. Patent No. 4,428,263, have sliced one loaf at a time, but could be expanded to slice two or more loaves simultaneously. But none of the prior high speed slicing machines have had the versatility needed to slice food loaves of the many different sizes and shapes referred to above, particularly with provision for either stackihg or shingling of the sliced output, variations in slice thickness and slice count from two different loaves, and precision control of the weight of slice groups. Moreover the previously known slicing stations have had problems with closing off the slicing station during machine clean up, sharpening of the knife blade, and unwanted intrusion of a food loaf into the slicing station at the wrong time.

Summary of the Invention

It is a principal object of the present invention to provide a new and improved versatile high speed slicing machine and method for slicing one, two, or more food loaves with a single cyclically driven knife blade with either automatic or manual loading, and with accommodation for food loaves that vary widely in dimensions, a machine and method that can vary the slice thickness and slice count for groups of slices cut simultaneously from different loaves.

A further object of the invention is to provide a new and improved versatile high speed slicing machine and method incorporating self-correcting precision control, preferably with internal computer control, so that the slicing machine output is adapted to a broad range of end use requirements.

Another object of the invention is to provide a new and improved high speed food loaf slicing station which inherently protects itself against entry of hot water or water vapor during cleanup and which has a "home" position.

Another object of the invention is to provide a new and improved conveyor/classifier system for the output of a versatile high speed food loaf slicing machine that weighs food loaf slice groups, as cut, at any speed within a broad speed range, regardless of whether the slice groups are stacked or shingled.

A further object of the invention is to provide a new and improved conveyor/classifier system for a versatile high speed food loaf slicing machine incorporating self-correcting precision weight control, preferably with internal computer control, so that the slicing machine output is adapted to a broad range of end use requirements.

Another object of the invention is to provide a new and improved method of manufacturing groups of food loaf slices, using a versatile high speed slicing machine, which method inherently protects against inadvertent slicing when not desired, can be used with food loaves of widely different sizes and shapes, and that incorporates self-correcting precision control so that the slicing machine is effectively adapted to a broad range of end use requirements.

Accordingly, in one aspect the invention relates to an improved high speed food loaf slicing machine comprising a slicing station including a knife blade and a knife blade drive driving the knife blade along a predetermined cutting path, and loaf support means for supporting a first food loaf and a second food loaf for movement along parallel first and second loaf paths, respectively, into the slicing station for repetitive slicing of both loaves by the knife blade. In one version the improvement comprises a first loaf feed drive for advancing the first food loaf along the first loaf path at a first preselected loaf feed rate, and a second loaf feed drive for advancing the second food loaf along the second loaf path at a second preselected loaf feed rate. Means are provided for varying one loaf feed rate independently of the other

so that slices cut from one loaf can differ in thickness from slices cut from the other. In another version the improvement comprises a first loaf storage tray for storing a food loaf ready for transfer to a loaf path, and first loaf transfer means for moving a food loaf from the first loaf storage tray to a loaf path. In another version the improvement comprises a first loaf gripper, on the first loaf path, actuatable between a gripping condition, in which the first gripper engages and grips the end of the first food loaf remote from the slicing station, on the first loaf path, and a release condition disengaged from the first loaf. A second loaf gripper, on the second loaf path, is actuatable between a gripping condition gripping a second food loaf and a release condition. The first and second grippers are actuatable independently of each other. In a further version the improvement comprises an elongated barrier aligned between and parallel to the first and second loaf paths, and barrier displacement means for displacing the barrier between a first position between food loaves on the food paths and a second position clear of food loaves on the food paths. In yet another version the improvement comprises a first pair of short feed conveyors engaging opposite sides of a first food loaf along the portion of the first loaf path immediately adjacent the slicing station, together with a second pair of short feed conveyors engaging opposite sides of a second food loaf along the portion of the second loaf path immediately adjacent the slicing station. In still another version the improvement comprises a loaf support means including first and second aligned supports separated from each other, in a direction parallel to the food paths, by a discharge space. There is a third support movable between a normal closed position in which the third support fills the discharge space and an open position in which the discharge space is open between the first and second support. Actuating means are provided for moving the third support member to its open position following completion of slicing of a food loaf and subsequently returning the third support to its normal closed position.

In another aspect the invention relates to an improved gripper for a high speed food loaf slicing machine comprising a slicing station including a knife blade drive driving the knife blade along a predetermined cutting path, loaf support means for supporting a food loaf for movement along a loaf path into the slicing station for repetitive slicing by the knife blade, a gripper for gripping the end of a food loaf, on the loaf path, remote from the slicing station, and gripper drive means for driving the gripper along the loaf path toward the slicing station and back. The improved gripper comprises a sensor for sensing engagement of the gripper with the end of a food loaf as the gripper moves along the food path toward the slicing station, and at least two gripping elements each actuatable between a loaf end gripping position and a release position. There is a gripping element actuator, responsive to the sensor, for actuating the gripping elements to their gripping positions when the sensor senses engagement with the end of a food loaf, and for actuating the gripping elements to their release positions when the gripper moves back along the food path.

In another aspect the invention relates to a slicing station for a high speed food loaf slicing machine including food loaf support means defining a food loaf path, loaf feed means for feeding a food loaf along the food loaf path toward a slicing station, and receiving means for collecting and removing groups of food loaf slices cut from the food loaf at the slicing station. In one version the slicing station comprises a knife blade movable along a predetermined cutting path through a slicing range intersecting the end of a food loaf on the food loaf path, and a cyclic drive, connected to the knife blade, for driving the knife blade cyclically along its cutting path at a predetermined cycle rate. There is a marker, movable with the knife blade as the knife blade moves along its Cutting path, and a sensor, mounted in fixed position in the slicing station, for sensing the presence of the marker at a preselected location indicative of location of the knife blade at a predetermined home position on its cutting path. In another version the slicing station comprises a slicing station housing and a knife blade, located outside the housing and movable along a predetermined cutting path through a slicing range intersecting the end of a food loaf on the food loaf path. A cyclic drive, enclosed within the slicing station housing and connected to the knife blade, drives the knife blade cyclically along its cutting path at a predetermined cycle rate. There is a marker movable with the knife blade as the knife blade moves along its cutting path, and a sensor, mounted in fixed position in the slicing station, for sensing the presence of the marker at a preselected location indicative of location of the knife blade at a home position on its cutting path. Sealing means are provided, actuatable between a relaxed non-sealing condition and a sealing condition in which the sealing means seals the slicing station housing against entry of fluids into that housing; the sealing means being actuatable to its sealing condition only when the blade is in its home position. In a further version the slicing station comprises a slicing station housing and a circular knife blade, located outside the housing and having a peripheral cutting edge. There is a knife blade drive for rotating the knife blade, and a rotatable spindle on which the knife blade is eccentrically mounted for movement of the knife blade cutting edge along a predetermined orbital cutting path through a slicing range intersecting the end of a food loaf on the food loaf path. A spindle drive rotates the spindle at a predetermined orbital cycle rate. A marker is mounted on the spindle for movement therewith, and a sensor is employed for sensing the presence of the marker at a predetermined location indicative of location of the knife blade at a home position on its cutting path. A honing device is included, mountable on the housing in engagement with the cutting edge of the knife blade when the knife blade is in its home position. Blade rotation means are provided to rotate the knife blade without rotating the spindle when the knife blade is in its home position. In a further version the slicing station comprises a knife blade movable along a predetermined cutting path through a slicing range intersecting the end of a food loaf on the food loaf path, and a cyclic drive, connected to the knife blade, for driving the knife blade cyclically along its cutting path at a predetermined cycle rate. A shear edge member is provided for guiding the end of a food loaf from the food loaf path into the cutting path of the knife blade, and shear edge mounting means

mount the shear edge member for movement in a predetermined direction toward and away from the knife blade cutting path.

In an associated aspect the invention relates to a shear edge member for a slicing station of a high speed food loaf slicing machine including food loaf support means defining a food loaf path, loaf feed means for feeding a food loaf along the food loaf path toward the slicing station, a shear edge member for guiding the food loaf from the food loaf path into the slicing station, the slicing station including a knife blade movable along a predetermined cutting path through a slicing range intersecting the end of a food loaf on the food loaf path and a cyclic drive for driving the knife blade cyclically along its cutting path a predetermined cycle rate, the slicing machine further comprising receiving means for collecting and removing groups of food loaf slices cut from the food loaf at the slicing station. The shear edge member comprises an elongated block of a machinable resin having at least one loaf-receiving opening for receiving one end of a food loaf on the food loaf path, and a plurality of resilient guides for guiding the food loaf into the loaf-receiving opening.

In yet another aspect the invention relates to a slicing station for a high speed food loaf slicing machine including food loaf support means defining first and second parallel food loaf paths, loaf feed means for feeding a food loaf along each food loaf path toward a slicing station, and receiving means for collecting and removing groups of food loaf slices cut from the food loaves at the slicing station. The slicing station comprises a knife blade movable along a predetermined cutting path through a slicing range intersecting the ends of food loaves on the food loaf paths, and a cyclic drive, connected to the knife blade, for driving the knife blade cyclically along its cutting path at a predetermined cycle rate. There are first and second loaf doors, each mounted for pivotal movement between a blocking position blocking access of a food loaf to the knife blade on one food loaf path and an inactive position clear of that path, and door actuation means to actuate each of the food loaf doors between its blocking and inactive positions.

In a further aspect the invention relates to an improved high speed food loaf slicing machine comprising a slicing station including a knife blade and a knife blade drive cyclically driving the knife blade along a predetermined cutting path, and loaf support means supporting a first food loaf and a second food loaf for movement along first and second loaf paths, respectively, into the slicing station for repetitive slicing of both loaves by the knife blade. The improvement comprises a receiver, including a receiver conveyor having a plurality of spaced receiver conveyor belts, located below the slicing station to receive food loaf slices cut from the first and second food loaves, respectively, to form a first food loaf slice group and a second food loaf slice group. There is a receiver lift mechanism connected to the receiver for moving the receiver vertically toward and away from the slicing station, and a receiver conveyor drive for driving the receiver conveyor horizontally at a predetermined discharge speed to discharge food loaf slice groups from the receiver. A deceleration conveyor receives food loaf slice groups from the receiver, and a deceleration conveyor drive drives the deceleration conveyor at a predetermined speed lower than the discharge speed.

In another aspect the invention relates to an improved high speed food loaf slicing machine including a slicing station in which a knife blade is driven cyclically along a predetermined cutting path and food loaf feed means for feeding a food loaf into the slicing station for repetitive slicing of the food loaf. The improvement comprises a receiver conveyor, including a plurality of horizontally spaced receiver conveyor belts, located below the slicing station to receive food loaf slices as cut in a food loaf slice group. A plurality of receiving pin wheels are each aligned with the space between two adjacent receiver conveyor belts; a receiver conveyor drive drives the receiver conveyor horizontally at a given speed and drives the receiving pin wheels at a peripheral speed equal to the given speed. A receiver lift mechanism is connected to the receiver conveyor for moving the receiver conveyor vertically toward and away from the slicing station.

In a method aspect the invention relates to a method of manufacturing a series of groups of food loaf slices, comprising the following steps:

A. driving a food loaf at a constant speed in a loaf feed direction toward engagement with a continuously cyclically driven knife blade for X knife blade cycles so that the knife blade cuts a slice from the food loaf in each knife blade cycle;

B. collecting successive food loaf slices cut in step A on a receiver to form a group of X food loaf slices on the receiver;

C. driving the food loaf away from the knife blade at a given speed for a given time interval Y;

D. again driving the food loaf toward the knife blade at the given speed for a second time interval Y to counteract step C;

E. during steps C and D, discharging the group of food loaf slices from the receiver;

F. after step E, weighing the group of food loaf slices to generate a weight signal representative of the weight of the food loaf slice group;

G. depositing the group of food loaf slices on a transfer conveyor;

H. deflecting the transfer conveyor between a reject position and an accept position in response to the weight signal of step F;

and repeating steps A through H in manufacturing a series of food loaf slice groups each including X slices.

Brief Description of the Drawings

In the Drawings:

Fig. 1 is a perspective view of a slicing machine comprising a preferred embodiment of the invention, with portions of the covers on the machine base cut away to show typical power supply and computer enclosures;

Fig. 2 is a perspective view, like Fig. 1, with some guards and covers for the loaf feed mechanism removed and some operating components shown in simplified form;

Fig. 3 is a perspective view, like Figs. 1 and 2, with other guards and covers cut away to show further operating components of the slicing machine, some illustrated in simplified form;

Figs. 4A, 4B and 5 are schematic, simplified illustrations of operating components of the slicing machine of Figs. 1-3;

Figs. 6A and 6B jointly comprise a flow chart for a computer control used in the slicing machine of Figs. 1-5;

Figs. 7A and 7B, which fit together as shown in Fig. 7C, jointly afford a longitudinal section view of principal components of the loaf feed mechanism for the slicing machine of Figs. 1-5;

Fig. 8 is a detail section view, similar to Fig. 7B, of a portion of the loaf feed mechanism that feeds loaves into the slicing station of the machine of Figs. 1-5;

Fig. 9 is a detail section view, on an enlarged scale, of a lower "short" conveyor used in the slicing machine of Figs. 1-5;

Fig. 10 is a plan view of a preferred construction for a gripper device used in the slicing machine of Figs. 1-5;

Figs. 11 and 12 are section views, taken approximately along line 11-11 in Fig. 10, showing the gripper actuated and unactuated, respectively;

Fig. 13 is a sectional elevation view of the automated loaf feed mechanism, taken generally as indicated by line 13-13 in Fig. 7B;

Fig. 14 is a sectional elevation view of the manual loaf feed mechanism, taken at about the same location as Fig. 13;

Fig. 15 is a perspective view of a gripper used in the slicing machine;

Fig. 16 is an explanatory diagram of slicing level variations in the slicing machine;

Figs. 17, 18 and 19 are plan, front elevation, and side views of one shear edge member used in the slicing station of the present invention;

Figs. 20 and 21 are front elevation views, like Fig. 19, of other shear edge members usable in the slicing station of the present invention;

Fig. 22 is a plan view of a horizontal adjustment mechanism for a shear edge member of the kind shown in Figs. 17-19;

Fig. 23 is a section view taken approximately along line 23-23 in Fig. 13;

Fig. 24 is a schematic sectional plan view of a portion of a slicing station constructed in accordance with the invention;

Figs. 25 and 26 are detail section views of the part of the slicing station of Fig. 15 enclosed in the circle marked Fig. 25 in Fig. 15;

Fig. 27 is a detail view that illustrates a honing device for use in the slicing station of the invention;

Fig. 27A is a simplified schematic illustration of an energizing circuit for the slicing station drives;

Fig. 28 is a detail view, on an enlarged scale, of a part of the honing device shown in Fig. 18;

Fig. 29 is a schematic drawing showing a different type of knife blade usable in some forms of the slicing station of the invention;

Fig. 30 is a timing chart employed to illustrate and explain the method of manufacturing groups of food loaf slices of the invention, using the slicing machine of the invention; and

Fig. 31 is a timing chart, on an enlarged scale, of two cycles from Fig. 30.

Description of the Preferred Embodiments

A. The Basic Slicing Machine, Figs. 1-3, 4A, 4B and 5.

Fig. 1 illustrates a food loaf slicing machine 50 constructed in accordance with a preferred embodiment of the present invention. Slicing machine 50 comprises a base 51 which, in a typical machine, may have an overall height H of approximately 32 inches (81 cm), an overall length L of about 103 inches (262 cm), and a width W of approximately 41 inches (104 cm). Base 51 is mounted upon four fixed pedestals or feet 52 (three of the feet 52 appear in Fig. 1) and has a housing or enclosure 53 surmounted by a top 58. Base 51 typically affords an enclosure for a computer 54, a low voltage supply 55, a high voltage supply 56, and a scale mechanism 57. Base enclosure 53 may also include a pneumatic supply or a hydraulic supply, or both (not shown).

Slicing machine 50, as seen in Fig. 1, includes a conveyor drive 61 utilized to drive an output conveyor/classifier system 64. There is a front side guard 62 extending upwardly from the top 58 of base 51 at the near side of the slicing machine 50 as illustrated in Fig. 1. A similar front side guard 63 appears at the opposite side of machine 50. The two side guards 62 and 63 extend upwardly from base top 58 at an angle of approximately 45° and terminate at the bottom 65 of a slicing station 66; member 65 constitutes a part of the housing for slicing station 66. There is a conveyor/classifier guard (not shown) between side guards 62 and 63, below the bottom 65 of slicing station 66.

The slicing machine 50 of Fig. 1 further includes a computer display touch screen 69 in a cabinet 67 that is pivotally mounted on and supported by a support 68. Support 68 is affixed to and projects outwardly from a member 74 that constitutes a front part of the housing of slicing head 66. Cabinet 67 and its computer display touch screen 69 are pivotally mounted so that screen 69 can face either side of slicing machine 50, allowing machine 50 to be operated from either side. Cabinet 67 also serves as a support for a cycle start switch 71, a cycle stop switch 72, and a loaf feed on-off switch 73. Switches 71-73 and display/touch screen 69 are electrically connected to computer 54 in base 51.

The upper right-hand portion of slicing machine 50, as seen in Fig. 1, comprises a loaf feed mechanism 75 which, in machine 50, includes a manual feed from the right-hand (far) side of the machine and an automated feed from the left-hand (near) side of the machine. Loaf feed mechanism 75 has an enclosure that includes a far side manual loaf loading door 79 and a near side automatic loaf loading door 78. Slicing machine 50 is equipped for automated loading of loaves from the near side, as seen in Fig. 1, and manual loading of food loaves on the far side of the machine. It will be understood that automated loaf loading may be provided on either or both sides of the machine; the same holds true for manual loaf loading. Indeed, different versions of slicing machine 50 may have automated loaf loading from the near side and manual loading on the far side, as shown herein, or can be reversed as regards the sides using manual and automated loading. Other versions of slicing machine 50 may have automated loaf loading or manual loaf loading on both sides of the slicing machine.

Slicing machine 50, Fig. 1, further includes a pivotable upper back frame 81 and an upper back housing 82. Back frame 81 supports the upper ends of many of the components of loaf feed mechanism 75. A loaf feed guard 83 protects the near side of the loaf feed mechanism 75 and shields mechanism 75 from a machine operator. There may be a similar guard on the opposite side of the machine. Behind loaf feed guard 83 there is a loaf lift tray 85 employed to load a food loaf into mechanism 75 during an automated loaf loading operation in machine 50 as described in detail below. A fixed loaf storage tray, used for manual loaf loading, may be located on the opposite side of machine 50 but is not visible in Fig. 1.

There are some additional switches seen in Fig. 1. An emergency stop switch 87 for interrupting all operations of slicing machine 50 is mounted on the near side of loaf feed guard 83. There may be a similar emergency stop switch

on the opposite side of the machine. A loaf lift switch 88 for initiating automated loading of a loaf from tray 85 into mechanism 75 is located immediately below switch 87. There would be a like switch on the opposite side of slicing machine 50 if that side of the machine were equipped for automated loaf loading. An emergency stop switch 89 is mounted on slicing station 66 on the near side of machine 50, and there is a similar switch (not shown) on the opposite side of the slicing station. Switches 87, 88, and 89, and any counterparts on the opposite (far) side of slicing machine 50, are all electrically connected to the controls in enclosure 54.

As shown in Fig. 1, slicing machine 50 is ready for operation. There is a food loaf 91 on tray 85, waiting to be loaded into loaf feed mechanism 75 on the near side of machine 50. Two, three, or even four food loaves may be stored on tray 85, depending on the loaf size. A similar food loaf or loaves may be stored on a corresponding loaf lift tray on the opposite side of machine 50. Machine 50 produces a series of stacks 92 of food loaf slices that are fed outwardly of the machine, in the direction of the arrow A, by conveyor classifier system 64. Machine 50 also produces a series of stacks 93 of food loaf slices that also move outwardly of the machine on its output conveyor system 64 in the direction of arrow A. Stack 92 is shown as comprising slices from a rectangular loaf, and stack 93 is made up of slices from a round loaf. Usually, both of the slice stacks 92 and 93 would be either round or rectangular. Stacks 92 and 93 may have different heights, or slice counts, and hence different weights; as shown, they contain the same number of food loaf slices in each stack, but that condition can be changed. Both groups of slices can be overlapping, "shingled" groups of slices instead of having the illustrated stacked configuration. Groups 92 and 93 must be the same in one respect; both must be stacks or shingle groups. Three or more loaves can be sliced simultaneously; slicing of two loaves is more common.

Fig. 2 illustrates the slicing machine 50 of Fig. 1 with a number of the covers omitted to reveal operating components of the automated loaf feed mechanism 75 on the near side of the machine. As shown in Fig. 2, there is a stack/shingle conveyor drive 101 located on the near side of slicing machine 50. One part of the drive for slicing station 66 is enclosed within a support enclosure 104 on the near side of machine 50. A manual slicing station rotation knob 103 is mounted on and projects into enclosure 104 for mechanical connection to the slicing station drive. At the opposite side of slicing machine 50 there is an enclosure 105 for a knife drive. Slicing station drive enclosure 104 and knife drive enclosure 105 extend upwardly from table top 58 at an angle, preferably approximately 45°, corresponding to the angular alignment of mechanism 75. There is a manual knife rotation knob (not shown) on the far side of machine 50, corresponding to knob 103.

A loaf tray pivot mechanism 107 is located above top 58 of base 51 on the near side of slicing machine 50. Mechanism 107 is connected to and operates the automatic loaf lift tray 85, as described below. A similar loaf tray pivot mechanism may be provided on the opposite side of slicing machine 50 in a machine equipped for automated loaf loading from both sides.

Slicing machine 50 includes a fixed frame pivotally supporting the automated feed mechanism 75 for feeding food loaves into slicing head 66. In the construction shown in Fig. 2, this fixed frame includes a pair of vertical frame members 111 affixed to base 51 and interconnected by two horizontal frame members 112 and joined to two angle frame members 113 (only one shows in Fig. 2). Frame members 111-113 are all located above the top 58 of machine base 51. The frame for loaf feed mechanism 75 in slicing machine 50 also includes a frame member 114 that extends from the upper back frame 81 downwardly, parallel to frame members 113, toward slicing head 66. The upper back frame 81 is mounted on pivot pins between the upper ends of two fixed frame members 127; only one member 127 appears in Fig. 2. All of the operating elements of the automated food loaf feed mechanism (see Fig. 5) are mounted on the back frame and are pivotally movable (through a small angle) relative to the fixed frame 111-113.

A manual feed tray 115 is shown at the far side of slicing machine 50 as illustrated in Fig. 2. A similar manual feed tray may be located at the near side of the machine in a slicing machine using manual feed from both sides of the machine.

The principal support for one or more food loaves in mechanism 75, whether food loaf loading is being carried out on an automated basis or on a manual feed basis, includes three support components, too of which are preferably of unitary one-piece construction. At the top of slicing machine 50, as seen in Fig. 2, there is an upper loaf support tray 116 that has its upper surface aligned with the top surface of a lower loaf support tray 117. Supports 116 and 117 are preferably one piece, being joined by side members omitted in Fig. 2 to avoid overcrowding. The gap between loaf supports 116 and 117 is normally filled by a loaf end discharge door 118; thus, members 116-118 normally afford a continuous loaf support surface that is the bottom for the two loaf paths in slicing machine 50. In Fig. 2, however, door 118 is shown in its open discharge position. Door 118 is hinged at the lower edge of loaf support 116 and can be elevated to provide a direct, uninterrupted surface for support of a loaf throughout mechanism 75 during most of the slicing operations carried out by machine 50. A textured upper surface is preferred for support members 116-118 to improve sliding movement of a food loaf along those support members toward slicing station 66.

The loaf feed mechanism 75 of slicing machine 50, Fig. 2, further includes a central barrier or divider 121. In the position for barrier 121 shown in Fig. 2, barrier 121 is used to position two food loaves on supports 116-118. This central barrier/divider 121 is suspended from frame member 114 by a plurality of pivotal supports 122, 123 and 124. During operation of slicing machine 50 divider 121 is elevated from the position shown in Fig. 2 (see Figs. 7A,7B) to permit loading of one or more food loaves onto the supports 116-118. Barrier 121 is also elevated during loaf slicing so that it will not interfere with other components of mechanism 75.

The part of food loaf feed mechanism 75 shown in Fig. 2 also includes a carriage 125 that is mounted upon a rotatable shaft 126 and a stationary shaft 128 that extend parallel to the loaf support 116-118 throughout the length of food loaf feed mechanism 75. That is, carriage 125 moves along shafts 126 and 128 on a path approximately parallel to support members 113. There is a like carriage, carriage shafts, and carriage drive on the far side of slicing machine 50.

Fig. 3 illustrates the same slicing machine 50 that is shown in Figs. 1 and 2 in a conceptual view showing additional components for loaf feed mechanism 75 and other parts of the slicing machine. Thus, Fig. 3 also illustrates the general arrangement of operating components within slicing head 66, one construction that may be used for conveyor/classifier system 64, and the drive motors for parts of slicing machine 50.

Referring first to conveyor/classifier system 64 at the left-hand (output) end of slicing machine 50, in Fig. 3, it is seen that system 64 includes an inner stacking or receiving conveyor 130 located immediately below slicing head 66; conveyor 130 is sometimes called a "jump" conveyor in some versions of machine 50. From conveyor 130 groups of food loaf slices, stacked or shingled, are transferred to a decelerating conveyor 131 and then to a weighing or scale conveyor 132. From the scale conveyor 132 groups of food loaf slices move on to an outer classifier conveyor 134. On the far side of slicing machine 50 the sequence is the same, but that side of system 64 ends with a second outer classifier conveyor 135 located next to conveyor 134; see Fig. 4B.

Slicing machine 50, Fig. 3, may further include a vertically movable stacking grid 136 comprising a plurality of stack members joined together and interleaved one-for-one with the moving elements of the inner stack/receive conveyor 130. Stacking grid 136 can be lowered and raised by a stack lift mechanism 138, as shown in Fig. 3. Alternatively, food loaf slices may be grouped in shingled or in stacked relationship directly on the receive/stack conveyor 130, with a series of stacking pins 137 replacing grid 136 (see Fig. 4B). When this alternative is employed, lift mechanism 138 is preferably connected directly to and is used for vertical positioning of conveyor 130.

Slicing machine 50 further comprises a scale or weighing grid comprising a first plurality of scale grid elements 141 and a second similar group of scale grid elements 142; each group of grid elements is interleaved one-for-one with the moving belts or like members of scale conveyor 132. Scale grids 141 and 142 are a part of scale mechanism 57 (see Fig. 1). A scale conveyor lift mechanism 143 is provided for and is mechanically connected to scale conveyor 132. There is no weighing mechanism associated with either of the two output or classifier conveyors 134 and 135. However, there is a classifier conveyor lift mechanism 144 connected to the near side classifier conveyor 134. A similar lift device 145 is provided for the other output classifier conveyor 135. Lift devices 144 and 145 are employed to pivot conveyors 134 and 135, respectively, from their illustrated positions to elevated "reject" positions, depending on the results of the weighing operations in machine 50 ahead of conveyors 134 and 135. See also Fig. 4B.

In Fig. 3, slicing station 66 is shown to include a rotating spindle or head 148. Head 148 is driven to rotate counterclockwise, as indicated by arrow D; the range of head speeds is quite large and may typically be from ten to seven hundred fifty rpm. A round knife blade 149 is shown rotatably mounted at a non-centralized location on head 148. Knife blade 149 is driven separately from head 148, rotating clockwise in the direction of arrow E. The range of knife blade speeds again is quite large and may typically be from ten to four thousand six hundred rpm. Blade 149 thus performs an orbital motion while it rotates. Other slicing head constructions may be used in machine 50, so long as the cutting edge of knife blade 149 moves along a predetermined cutting path in each cycle of operation; however, the illustrated configuration is preferred.

As shown in Fig. 3, loaf feed mechanism 75 includes a near side clamp or gripper mechanism 151. There is a similar gripper mechanism (not shown) at the far side of slicing machine 50. Gripper 151, which is connected to carriage 125 (Fig. 2), may have the construction shown in Fig. 15, or it may use the preferred construction of Figs. 10-12.

Loaf feed mechanism 75 further comprises a near side sweep member 153 suspended from too sweep carriages 154 which in turn are each mounted upon a pair of sweep support rods 155. Sweep mechanism 153-155 is employed on the near side of machine 50. A corresponding sweep mechanism (not shown) may be located on the far side of a slicing machine equipped for automated loaf loading from both sides. A somewhat different manual food loaf load arrangement is used in machine 50; see Fig. 14. Sweep carriages 154 are driven along rods 155 by belts, not shown in Fig. 3, as indicated by arrows B. Rods 155 are connected to a rotatable sweep actuator 156 for actuation thereby.

Slicing machine 50 is intended to accommodate food loaves of widely varying sizes; it can even be used as a bacon slicer. This makes it necessary to afford a height adjustment for the food loaves as they move from loaf feed mechanism 75 into slicing head 66. In Fig. 3, this height adjustment, described more fully hereinafter, is generally indicated at 161.

Slicing machine 50 further comprises a system of short conveyors for advancing food loaves from loaf feed mechanism 75 into slicing head 66. The short conveyor systems are actually a part of loaf feed mechanism 75. Fig. 3 shows two short lower loaf feed conveyors 163 and 164 on the near and far sides of slicing machine 50, respectively. These short lower conveyors 163 and 164 are located immediately below two short upper feed conveyors 165 and 166, respectively. As used in describing conveyors 163-166, the term "short" refers to the length of the conveyors parallel to the food loaf paths along support 116-118, not to the conveyor lengths transverse to those paths. The upper conveyor 165 of the pair 163 and 165 is displaceable so that the displacement between conveyors 163 and 165 can be varied to accommodate food loaves of varying height. This adjustment is provided by a conveyor lift actuator 167 that urges conveyor 165 down-

wardly. A similar conveyor actuator is located on the far side of machine 50 to adjust the height of the other upper short conveyor 166; the second actuator cannot be seen in Fig. 3.

Some of the drive motors for the operating mechanisms in slicing machine 50 are shown in Fig. 3. The drive motor for the head or spindle 148 in slicing station 66 is a D.C. variable speed servo motor 171 mounted in the machine base 51. A similar servo motor 172 drives the knife blade 149. The receiver lift mechanism 138 is driven by a stacker lift motor 173, again preferably a variable speed D.C. servo motor. On the near side of machine 50 the loaf feed drive mechanism comprising gripper 151 and the short loaf feed conveyors 163 and 165 is driven by a servo motor 174. A like motor 175 on the far side of machine 50 (not shown in Fig. 3) affords an independent drive for the gripper and the "short" loaf feed conveyors 164 and 166 on that side of the slicing machine; see Fig. 4B.

Fig. 4A affords an extended, simplified illustration of the slicing station 66 of the slicing machine of Figs. 1-3, along with the loaf feed drives. In Fig. 4A, servo motor 174 is shown connected, as by a series of timing belts 177 and a pair of universal-joint drive connectors 178, in driving relation to loaf feed conveyor drive pulleys 181 and 182 and to another loaf feed belt drive pulley 180. Pulley 181 is the drive pulley for the near side lower "short" loaf feed conveyor 163; pulley 182 is the drive pulley for the near side upper "short" loaf feed conveyor 165 (Fig. 3). Pulley 180 is the drive pulley for a belt 334 (Fig. 6) that drives gripper carriage 125. All of the loaf feed drive pulleys 180-182 (Fig. 4A) have the same peripheral speed. Variation of the operating speed of servo motor 174 serves to vary the speed at which one food loaf (e.g., loaf 502) is advanced into slicing station 66.

On the far side of Fig. 4A there is another servo motor 175 that, through a series of belts 184 and a pair of universal-joint drive connectors 185, drives the drive pulleys 187 and 188 for the far side "short" loaf feed conveyors 164 and 166; see Fig. 3. Motor 175 also drives a drive pulley 189 for a gripper carriage drive belt (not shown) that is a part of the food loaf feed on the far side of machine 50. The peripheral speeds for the loaf food drive pulleys 187-189 are all the same. The two servo motors 174 and 175 are adjustable in speed, independently of each other. Thus, either motor may have its speed regulated to adjust slice thickness for one loaf (e.g. loaf 503) independently of the other (e.g. loaf 502).

Fig. 4A schematically illustrates the drive connection from servo motor 171 to the head or spindle 148 in slicing station 66, through a belt 190; head 148 rotates counterclockwise as indicated by arrow D. Servo motor 172, on the other hand, rotates knife blade 149 clockwise (arrow E) through a drive connection afforded by two timing belts 191. Orbital movement of knife blade 149 depends upon the rotational speed of servo motor 171 and the speed of rotational movement of the blade is controlled by motor 172. Each can be varied independently of the other. A marker 901 is mounted on spindle 148; a sensor 902 is positioned to detect the presence of marker 901. Marker 901 may be a permanent magnet. Devices 901 and 902, when aligned, determine that spindle 148 is in a predetermined "home" position; when head 148 is in its "home" position, as shown in Fig. 4A, blade 149 is also located at "home". Marker 901 may comprise a small permanent magnet and sensor 902 can be an electromagnetic sensor responsive to magnetic flux.

Fig. 4B shows the manner in which lift motor 173 is connected to receiving conveyor 130 by lift mechanism 138; the drive connection is afforded by connection of a yoke 192 to a timing belt 193 driven by servo motor 173. Thus, motor 173 acts to lift or lower receiver conveyor 130; these actions (arrows F) are carried out cyclically for each group of slices cut from a loaf or loaves 502 and 503 fed into slicing station 66 in the direction of arrow L, Fig. 4A. Conveyor 130 also requires a drive motor, shown in Fig. 5 as the servo motor 176, driving conveyor 130 through a belt 194 in drive 101. During slicing of a pair of loaves motor 176 may rotate slowly in the direction of arrow C (clockwise as seen in Fig. 5) while motor 173 and mechanism 138 lower conveyor 130 to obtain precise vertical stacks for each group of slices from each loaf. If shingled groups are desired, motor 176 rotates slowly counterclockwise (opposite arrow C) while the loaves are sliced. When the slice groups are complete, motor 176 drives conveyor 130 and stacker pins 137 rapidly counterclockwise to shift the group of slices, stacked or shingled as the case may be, onto deceleration conveyor 131. Thereafter, motor 173 again elevates the receiver conveyor 130 rapidly to be in an elevated position, ready to receive two new groups of food loaf slices.

As shown in Fig. 4B, conveyors 131 and 132 share a common shaft 129, also seen in Fig. 3; a pulley 133 is mounted on shaft 129. Shaft 129 and pulley 133 are at a fixed height. The end of conveyor 131 opposite pulley 133 is adjustable upwardly and downwardly to the level necessary to receive groups of food loaf slices from conveyor 130; see arrows G in Fig. 4B. The vertical movements of conveyor 131 are provided by mounting the inner end of conveyor 131 (right hand end as seen in Fig. 4B) on a yoke 197 that is moved upwardly or downwardly by a motor 196. Motor 196 may comprise a pneumatic device, but a hydraulic device or an electrical motor could be used. The height of the end of deceleration conveyor 131 connected to yoke 197 does not change during slicing.

The outer (left-hand) end of scale conveyor 132 is dropped a short distance and subsequently elevated to the position illustrated in Fig. 4B each time a group of food loaf slices (usually two groups side-by-side) traverses the scale conveyor; see arrows H. This brief vertical movement of the outer end of conveyor 132 is effected by the scale lift mechanism 143. A pneumatic cylinder is preferred for lift 143; a hydraulic cylinder or an electrical linear motor could be used. When the outer (left-hand) end of conveyor 132 moves down, any group or groups of slices on conveyor 132 are deposited momentarily on scale grids 141 and 142 and weighed by load cells 198 and 199 respectively (grids 142 are not shown in Fig. 4B). Mechanism 143 promptly moves scale conveyor 132 back up to again lift and carry the slice groups onward to classifier conveyors 134 and 135. Each group of food loaf slices that weighs in within a preset tolerance range is dis-

charged downwardly with its classifier conveyor held down in the "in tolerance" position shown for classifier conveyor 134 in Fig. 4B. The weight tolerance range may be different for slice groups on the near and far sides of scale conveyor 132. Each group of slices that does not come within the selected weight range is diverted upwardly by its classifier conveyor, held elevated in the "reject" position shown for conveyor 135 in Fig. 4B. Vertical movements of the outer ends of classifier conveyors 134 and 135 are effected by linear lift mechanisms 144 and 145 for conveyors 134 and 135 respectively. Pneumatic cylinders are preferred for devices 144 and 145, but other mechanisms could be employed.

Each time scale conveyor 132 is moved downwardly (arrows H) by its lift mechanism 143, so that a group of food loaf slices on the scale conveyor is deposited on scale grid 141 on the near side of the slicing machine, load cell 198 weights that group of slices. It is this weighing operation that determines whether the classifier conveyor 134 is maintained in the lower "in tolerance position shown in Fig. 4B or is moved up to the "reject" position shown for conveyor 135 in Fig. 4B. Load cell 199 performs the same basic weighing operation for each group of food loaf slices on the far side of the machine. Thus, weight signals from load cells 198 and 199 are used to actuate cylinders 144 and 145 to elevate conveyors 134 and 135, respectively, to their "reject" alignments when food loaf slice groups are not in the preset weight ranges established for the loaves being sliced. Conversely, if a slice group weight is within the weight tolerance range, when weighed by one of the load cells 198 and 199, the signal from the applicable load cell is used to actuate the associated cylinder 144 or 145 to move the related classifier conveyor 134 or 135 down to its "in tolerance" position or to maintain that classifier conveyor down in the "in tolerance" position.

Conveyors 131, 132, 134 and 135 all are driven at the same preselected speed, in the direction of arrow A, Fig. 4B. That speed is adjusted to fit requirements imposed by the speed of the cutting blade in station 66, Fig. 4A. A conveyor drive motor 260 (Fig. 4B) is connected to a timing belt 261 that drives a spindle/pulley 262 serving both classifier conveyors 134 and 135. The drive spindle/pulley 262 is mounted on a shaft 263; the end of shaft 263 opposite belt 261 carries a drive pulley 264 in mesh with a timing belt 265 used to rotate shaft 129 and the spindle 133 that drives both of the belt conveyors 131 and 132.

Fig. 5 affords a simplified schematic illustration of most of the loaf loading and loaf feed mechanisms in the slicing machine. Starting at the left-hand side of Fig. 5, it is seen that there is a loaf lift cylinder 365 having an actuating rod 266 connected to a crank 267 that in turn drives a loaf lift lever 268. These members are a part of the loaf lift mechanism 107 that lifts storage tray 85 from its storage position (Figs. 1-3) into alignment with the support 116-118 (Fig. 2) on which food loaves rest during slicing. The loaf lift mechanism is actuated only during loaf loading; during a loaf feeding/slicing operation, cylinder 365 (Fig. 5) is not normally actuated and keeps tray 85 in its storage position. However, tray 85 may be elevated, ready to load a new loaf or loaves into feed mechanism 75, near the end of slicing.

Fig. 5 shows the "short" conveyors 163-166, with the two upper "short" conveyors 165 and 166 mounted on the housings of cylinders 167. Cylinders 167 have fixed shafts; air applied under pressure to the cylinders tends to drive their housings, and hence conveyors 165 and 166, down toward the lover conveyors 163 and 164. Downward movement of the upper conveyors is blocked by a shear edge member 501 that is specific to the size of loaves being sliced, so that each pair of the conveyors engages opposite sides (top and bottom) of a food loaf being sliced. The drive spindles 181, 182, and 187 for conveyors 163, 165 and 164 appear in Fig. 5; their drives are shown in Fig. 4A.

The drive pulley 180, shown in Fig. 4A, also appears in Fig. 5. It is in meshing engagement with a near side timing belt 334 that extends the full length of the loaf feed mechanism 75. Belt 334 is connected to the gripper carriage 125 on the near side of the slicing machine and is used to drive the carriage toward the slicing station. There is a like gripper carriage 125 driven by another long timing belt 334 on the far side of the machine. Two parallel shafts 126 and 128 guide movements of each of the carriages 125. Shafts 128 are stationary but each of the shafts 126 can be rotated by means of a loaf door cylinder 271 and a connecting crank 272. Each carriage 125 has an extension 597 for connection to a loaf end gripper.

Returning to the left-hand side of Fig. 5, it is seen that there are two loaf doors 377, one on each side of the feed mechanism 75, immediately to the right of conveyors 163-166. The near side loaf door 377 is mounted on shaft 126 so that it can be rotated to close off access of a food loaf into the space between conveyors 163 and 165. Similarly, the far side loaf door 377 is mounted on the other shaft 126 and can be rotated to close off access of a food loaf into the space between conveyors 164 and 166.

Fig. 5 shows the central barrier or divider 121 that is suspended from an auxiliary frame member 114 by three pivotal hangers 122-124. The hanger 122 at the right-hand end of barrier 121, as seen in Fig. 5, is connected by a shaft 304 to an air cylinder or other linear actuator 302. Linear actuator 302 can be used to lift barrier 121, pivotally, to a point clear of any food loaves in the loaf feed mechanism, as described hereinafter.

On the near side of the slicing machine, in mechanism 75, there is an elongated sweep 153; see the lower right-hand portion of Fig. 5. Sweep 153 is suspended from two hangers/carriages 504, each connected to a drive belt 507. There are structural members, not shown in Fig. 5, that afford further support for the hanger-carriages; see Fig. 3. Belts 507 are timing belts, each engaging a drive pulley 508 and an idler pulley 509. The idlers 509 are mounted on a shaft 511. The drive pulleys 508 are affixed to a shaft 505 rotated by a loaf sweep motor 281.

Fig. 5 shows a loaf discharge door 118 that is a central part of the loaf support for the slicing machine. Door 118 is shown, in Fig. 5, in its elevated normal position, the position the door occupies when slicing is going forward. Door 118

is connected by a long rod 325 to a linear actuator 321 that opens the door to allow discharge of an unsliced butt end of a loaf, as described below.

Some of the manual loaf loading components of mechanism 75 do not appear in Fig. 5; they are masked by the manual loaf door 79 which is mounted on a shaft 515. Shaft 515 is rotated by a manual door cylinder 291 connected to the shaft by its operating rod 292 and a crank 293.

B. The Computer Flow Chart, Figs. 6A and 6B.

Slicing machine 50 (Figs. 1-3) is fully computer controlled. Accordingly, basic operation can be described in conjunction with a flow chart indicative of the control functions carried out by the computer program. Figs. 6A and 6B afford the requisite flow chart; Fig. 6B follows Fig. 6A. The basic preferred driver software is TOUCH BASE driver software, licensed by Touch Base, Ltd. through Computer Dynamics of Greer, South Carolina; this driver software package allows operation of the touch screen functions used in slicing machine 50. If this driver software does not load on start up there is a serious problem with computer control.

At the outset, when slicing machine 50 is first placed in operation, power to the machine is turned on, as by actuation of an appropriate input power supply switch. This input power switch is not shown in the drawings; the power supply switch may be located in or on base 51 of machine 50. Calibration of the touch screen may be required on start up; if so the operator of the slicing machine initiates calibration by actuating switches 72 and 73 (Figs. 1-3) simultaneously. If no calibration is needed, the first step in computer control of machine 50, in the initial part of the flow chart (Fig. 6A), is an initial start 201, also effected by the machine operator. This may be accomplished with the power supply switch referred to above, or an additional switch may be interposed in the circuit to energize computer 54 through the low voltage power supply 55 and the display/touch screen 69 (Fig. 1). In the next step 202 of the flow chart, a check is made to determine if the driver software is loaded; if not, a warning reset is supplied to step 201.

Once the driver software is loaded for step 202, and screen 69 has been energized, the program recorded in computer 54 (Fig. 1) performs a sequence of initial functions, indicated by step 203 in Fig. 6A. These initial functions may include initializing interrupt of vectors, graphics driver, determination of spindle tracking hours, establishment of product codes for defaults, and a check of a battery energized backup record memory (RAM). The computer program also sets the appropriate code to match the product to be sliced by the machine, selects several action boards previously set up in the computer, makes a determination of motion control interrupt functions, establishes raw data for scale arrays related to the food loaf products and the slicing operation, and selects previously recorded graphics pertaining to a wide variety of different products so that the graphics subsequently displayed on screen 69 match the product being processed. In addition, the computer program, in the course of the initial functions step 203 (Fig. 6A), sets the maximum knife speed ratio relative to the speed of slicing head 66 required for the desired slicing operation. For any of these initial functions, some input from the machine operator may be necessary; most inputs are effected by operator touch on screen 69 (Figs. 1-3).

At this juncture, the touch/display screen 69 has been energized; the computer program for machine 50, in step 204, Fig. 6A, sets up a title page on the screen pertaining to the slicing and grouping operation or operations to be performed by machine 50. At the same time, or immediately thereafter, the computer program operates (step 205) to start up various power systems in machine 50. These functions may include initialization of an air pressure system or a hydraulic pressure system in machine 50, or both, depending on the requirements of operating components in the machine. Pneumatic actuation is usually preferred. A motor control power circuit, included in the high voltage power supply 56 (Fig. 1), is energized so that electrical motors (mostly A.C. servos) used to perform various functions in machine 50 have power available. In step 205 the computer program also determines appropriate sample periods for weighing operations and a seam correction for the scales actuated by weighing grids 141 and 142; the sample periods may be the same if machine 50 is to produce just one product from two or more separate loaves. In step 205 the computer program also determines the average slice thickness required for each product from machine 50. Again, the slice thicknesses (and the loaf and knife speeds that determine those thicknesses) may be the same, or they may be different for loaves sliced on the near and far sides of machine 50.

Once the computer program has completed the initializing functions of step 205, Fig. 6A, it starts an idle loop operation as indicated in step 206. This idle loop start step can go forward only if there are appropriate inputs from two flag determinations performed in steps 234 and 237 in Fig. 6B. When machine 50 has been idle, as is assumed, appropriate inputs are available from both of the two steps 234 and 237 in Fig. 6B.

At the beginning of the idle loop operation, step 206 in Fig. 6A, the program for slicing machine 50 tracks the running of calculation of a total time for the anticipated run of the slicing machine by reading start time and stop time and taking the difference; the computer also performs a plurality of other tracking functions in step 207 (Fig. 6A). Thus, the computer records the total run time and also records the total time for power to be on, which may be somewhat longer. In step 207, the computer program may make a determination of the time period permissible before service of slicing machine 50 is required.

When these operations have been completed in step 207 the computer determines if an emergency stop check can be cleared in the next step 208. What this amounts to is a check to determine whether any of the emergency stop switches 87 and 89 have been actuated. If an emergency stop signal has been recorded, there is a "yes" output at step 209 in the program, resulting in initiation of a subsequent step 211. In step 211 the computer records a fault message, turns off all machine outputs, and stops all machine motors. If there is a "no" output at step 209, indicative of the fact that no emergency stop switch has been actuated, then a step 212 is carried out by the computer to clear any emergency stop message that may be held over from previous operations and to clear all flags from the control system.

In the next program step 213, Fig. 6A, the computer of slicing machine 50 makes a determination as to whether an emergency stop has been set. If this action has occurred, the next step 214 is the performance of a servo check by the computer and a determination of whether the drives for machine 50 are not ready for operation or if there has been a fault due to a thermal overload. In this step 214 the computer also may set a "stop now" flag. If such a flag is set, in the next step 215 the existence of that flag is identified and a further program step 216 is initiated to stop all motion in the slicing machine 50 and to carry out a normal shut down of that machine.

Returning to step 213, the computer may ascertain that no emergency stop has been set. In this circumstance, a step 217 is initiated to check whether all guards and doors have been closed on machine 50 and the motor drives for the slicing machine are ready for operation. In step 217 the computer also makes a determination of whether electrical faults have occurred as a result of vibration or other causes. If no fault is ascertained, an enabling output is produced in the next step 218 and fed back to the servo check of step 214. If a fault is found, the next program step 219 is initiated, setting a fault message, turning all outputs off, and stopping all motors in the slicing machine 50. The output from step 219 is supplied back to the servo check step 214. In Fig. 6A, it will be seen that steps 207-209 and 211-219 are all enclosed in a phantom outline 221, which is referred to again hereinafter in conjunction with a portion 248 of Fig. 6B.

The next step in the flow chart of Fig. 6A is a determination of whether a product removal flag has been set; see step 222. If such a flag has been set, a subsequent program step 223 is initiated. At this juncture, if the operator has held the load feed switch 73 (Fig. 1) actuated for a predetermined minimum period (typically five seconds) then the computer program prepares for product removal. Completion of step 223 or a determination in step 222 that no product removal flag has been set results in initiation of a further step 224, constituting a display of an emergency stop message on display screen 69 (Fig. 1), if previously set.

Following step 224, in the next step 226 of Fig. 6A the recorded program of slicing machine 50 checks to determine whether a flag has been set to preclude jogging of the conveyor system 64. If there is an affirmative output from step 226, a subsequent step 227 starts jogging movement of the conveyor system. An output from step 227 or a negative output from step 226 initiates a subsequent step 228, which is a check to determine whether a flag has been set for stopping jogging movement of the conveyor system. If no such flag has been set there is an output to the initial stage 232 of Fig. 6B. If there is an affirmative output from step 228, then an additional step 229 is carried out to stop jogging movement of the conveyor system 64 (Fig. 1).

Fig. 6B shows the steps for the remainder of the flow chart that began with Fig. 6A. At the beginning of the portion of the flow chart shown in Fig. 6B, there is a program step 232 in which the computer looks to see if there has been a start run and a fault set. If both conditions have occurred while attempting to start a run cycle, there is a yes output from step 232 to the next step 233 and a disabling cycle is initiated for slicing machine 50 by the program prerecorded in its computer. In the course of step 233, if there has been a run flag, so that running of the machine is not permissible, that flag may be cleared. Of course, the stated combination of conditions (lack of a start run or a run fault set) may not be found in step 232, in which case step 233 is by-passed. In either event, there is an enabling input to a further step 234 in the computer program, which again checks for the existence of a run flag. Actually, in step 234 the program is checking to see whether the cycle start switch 71 has been actuated by the operator. If not, there is an output to step 206 in Fig. 6A. If the operator has actuated the run/start control switch, there is an enabling output to the next step 235 in the flow chart.

In step 235 of the flow chart, Fig. 6B, the computer performs a variety of functions. To begin with, it records the time that machine 50 has been out of operation for faults and starts a number of machine subsystems in operation. Thus, in display 69 the computer program causes the display of a homing message. The knife 149 in slicing head 66 (Fig. 3) is brought to a home orientation. The clamps 151 of loaf feed system 75 (see Fig. 3) are also brought to their respective home positions. Other homing operations are performed for the conveyors of conveyor system 64. The computer checks to see if the enclosure doors for loaf feed system 75 are closed, as shown in Fig. 1. Center divider 121 (Figs. 2 and 3) is raised to its elevated position, high enough to be clear of any loaf that may be moved onto the loaf supports (116-118) of the slicing machine. Grippers 151 are unactuated; see Fig. 12. The controls of machine 50 are set for automatic or manual loading. The loaf cover is raised, stacking conveyor 130 is elevated, and motion control for the machine is checked to see whether it has been cleared. The anticipated production start time is also recorded in step 235. When all of these operations have been completed, an output to step 236 in the flow chart is effected; machine 50 is now ready to start slicing. It is assumed that there is an appropriate input to program step 236 from the final step of the flow chart, as described below.

In the next step 237 of the program illustrated by the flow chart of Fig. 6B, the computer of machine 50 ascertains whether a flag has been set to permit running operation. This is a requirement imposed upon the machine operator. If it has not been fulfilled, there is a no output from stage 237 to step 206 in the portion of the flow chart illustrated in Fig. 6A, so that machine 50 reverts to its idle mode of operation. However, if the operator has set a run flag to indicate that machine 50 is ready for slicing and that such operation is desired, then there is an output from program step 237 to the next step 241.

It may be desirable to check for profile variations at the beginning and end of each food loaf sliced, in order to track taper of the loaf and make thickness corrections according to loaf profile trends. If profile corrections are to be made, step 241 affords a YES output to the next step 242 to make profile corrections. If there are to be no profile corrections, or if none are required, the next input is to program step 243. At this point, the touch screen 69 is checked to see if the operator has entered instructions by means of a touch; the selected screen image is displayed. In the succeeding step 244 the computer checks to see if gross weight is to be measured. If the answer is YES, a gross weight for the product is determined in step 245. When that weighing step is completed, or if no gross weight is to be determined, the flow chart goes on to a further step 246. In the next step 246 the computer ascertains whether a stop switch has been actuated or a fault has been found by the sensor switches of machine 50, such as sensor switches that determine whether all guards are in place. If, in step 246, it is determined that operation of the slicing machine 50 should not begin, then in the next step 247 all motion within the machine is interrupted and a normal shutdown is carried out. Step 247 is by-passed if there is a negative condition ascertained in step 246. After step 247, the program represented by the flow chart performs functions, in a composite step 248 that correspond in all respects to the functions described above for steps 207-209 and 211-219 in phantom outline 221 of Fig. 6A.

After the composite step 248, Fig. 6B, an input to the next step 252 in the flow chart may result in a determination that the gripper clamps 151 of machine 50 (Fig. 3) need to be retracted, or that they do not need to be retracted. If the clamps must be retracted, then program step 253 comes into play. The clamps are retracted, and the average load time and number of loaves are tracked. On the other hand, step 253 in the program may be by-passed by a negative output from step 252. In either case, there is an enabling input to program step 254, where it is ascertained whether the grippers 151 are ready to grip food loaves. If yes, the gripping operation of step 255 is initiated. If no, the next subsequent step 256 is enabled. Step 256 may also be enabled by an output from step 255. As the food loaf slice groups constituting the output of slicing machine 50 move to position to be weighed on conveyor 132, an appropriate input has been made, prior to this time, by the computer program. In step 256 of the program flow chart, a positive output results in an enabling signal to the next step 257, to cause the machine to weigh each product slice group as it leaves the machine. If the sliced product group (or groups) is not in position for weighing, there is a negative output from step 256, or an output from step 257, supplied to the run loop start step 236 to maintain the slicing machine in operation. Either way, operation continues until a given desired slicing operation is finished.

C. Loaf Feed Mechanisms, Figs. 7-12.

Figs. 7A, 7B, 8 and 9 illustrate many features of the present invention. Fig. 7C shows how Figs. 7A and 7B abut each other. All are concerned with the mechanism 75 used to feed two or more food loaves along parallel paths, each defined by the supports 116-118 that lead into slicing head 66. See Figs. 1-3 and 5.

As shown in Fig. 7A, the back frame 81 comprises a transverse frame member 301 mounted for limited pivotal movement about a pair of pivots 310 (only one shown). Indeed, all of the operating components of loaf feed mechanism are pivoted for very limited movement about pivots 310. This includes auxiliary frame member 114, shafts 126 and 128, conveyors 163-166, drive belts 334, and shafts 505 and 515; see Fig. 5. As indicated in Fig. 7A, actuator 302, which may be a pneumatic, hydraulic or electrical linear actuator, is mounted on frame member 301. A pneumatic actuator is preferred. The operating rod 303 of actuator 302 is connected to one end of drive rod 304 by a connector 305. The direction of movement of rods 303 and 304 is indicated by an arrow I. The other end of drive rod 304 is connected to the leg of the first pivotal barrier support member 122. Support member 122 is generally T-shaped, rotated 90° so that the leg of the T is horizontal and the bar of the T is vertical. One end of the bar portion of support 122 is pivotally connected to frame member 114 at a pivot 306. The other end of the bar of support 122 is pivotally connected to barrier 121 at a pivot 307.

The remaining supports 123 and 124 for barrier 121 are shod in Fig. 7B. Each is a simple linear vertical support bar, pivotally connected to a fixed point on frame member 114 at a pivot 308 and connected to barrier 121 at a pivot 309.

The divider 121, which is preferably generally V-shaped in cross section (see Figs. 13 and 14), constitutes an elongated barrier located at the center of the loaf feed mechanism 75 between the first and second loaf paths of the slicing machine. In Figs. 7A and 7B barrier 121 is shown in solid lines in a first operating position, in which the barrier is engageable with the adjacent inner surfaces of two feed loaves (not shown). When a new loaf is fed into mechanism 75, whether manually or automatically, barrier 121 is displaced to a second operating position 121A clear of any food loaves on the food loaf paths. Barrier 121 is also held elevated in its second operating position 121A while food loaves are sliced.

Displacement of barrier 121 between its first and second operating positions is effected by the barrier displacement means 302-305, Fig. 7A.

Thus, before a new food loaf is loaded into loaf feed mechanism 75, from either side of slicing machine 50, linear actuator 302 has been energized and has driven the piston rod-connector rod assembly 303-305 in the direction of arrow I, Fig. 7A. This movement of connector rod 304 rotates barrier support member 122 clockwise along path 311, as seen in Fig. 7A, to the position indicated by phantom outline 122A, moving barrier 121 to its elevated second operating position 121A. Because barrier 121 is connected in a parallelogram structure with pivotal supports 123 and 124, the complete barrier is moved up to its second operating position, shown by phantom outlines 121A in Figs. 7A and 7B.

After a new loaf or new loaves (not shown) have been transferred into mechanism 75, linear motor 302 is deenergized, assuming a spring-return linear actuator is employed. If there is no spring return or the like in actuator 302, reverse energization may be used. In either event, the piston rod/connection rod assembly 303-305 is pulled back, opposite to arrow I, Fig. 7A, and barrier 121 is pulled down to the first operating position shown in solid lines in Figs. 7A and 7B. A positive return drive is preferred, so that on its return (downward) movement barrier 121 is forced between the loaves in mechanism 75 to align them accurately on the parallel food paths on supports 116-118, the food paths that end at slicing head 66. Linear actuator 302 is again energized to shift barrier 121 back to its alternate position 121A after the loaves have been engaged by grippers 151 (as described below) so that the barrier does not interfere with air and/or other lines connected to the grippers.

The loaf feed mechanism, Figs. 7A and 7B, includes two rotatable shafts 126; only one shaft 126 appears in Figs. 7A and 7B. The two rotatable shafts 126, one on each side of the slicing machine, are generally parallel to the main frame members 113. However, these shafts, and the other components of the loaf feed mechanism in machine 50, are movable through a small range, relative to slicing head 66, to accommodate variations in loaf size. Two additional, non-rotatable shafts 128 are included in the loaf feed mechanism 75, parallel to shafts 126. Only one shaft 126, one shaft 128, and one main frame member 113 appear in Figs. 7A and 7B. The loaf supports 116 and 117, which are parallel to shafts 126 and 128, remain in place at all times when the slicing machine is ready for operation or in operation. During cleanup of machine 50, they are dropped to afford access to portions of the loaf feed mechanisms. Door 118, which closes the gap between trays 116 and 117, serves a more active purpose.

The door actuator 321, which may be a pneumatic, hydraulic, or electrical linear actuator, is mounted on member 301 within the housing 82 of back frame 81, Fig. 7A. A pneumatic actuator 321 is preferred. The operating rod 322 of door actuator 321 is connected to one end of a link 323 that projects through a sleeve 324 in frame member 301; the other end of link 323 is pivotally connected to one end of a connector rod 325. The other end of rod 325 is pivotally connected to a depending portion 326 of door 118; see Fig. 7B. Door 118 is pivotally mounted on a horizontal shaft 327 that extends across loaf feed mechanism 75.

Door 118 has two operational positions. In its elevated or closed position, shown in solid lines in Fig. 7B, the upper surface of door 118 is flush with and constitutes a substantially continuous bridge between the upper surfaces of loaf trays 116 and 117. That elevated position is usually occupied by door 118 while food loaves are fed along the loaf paths, of which door 118 is a part, leading into slicing head 66 (Figs. 1-3 and 5). But when slicing nears completion, actuator 321 (Fig. 7A) is energized to pull its piston 322 and rods 323 and 325 to the right, as seen in both of Figs. 7A and 7B. This movement pivots door 118 counterclockwise, as seen in Fig. 7B, to its alternate open position 118A. Consequently, when a gripper 151 clamped on the end of a loaf is moving back to its home position, the position shown in Fig. 7A, the gripper can be actuated to release the loaf butt as it passes over the gap in the loaf paths created by dropping door 118 to its open position 118A, Fig. 7B. Door 118 is preferably closed, as by de-energizing or reverse energizing linear actuator 321, before new food loaves are deposited on supports 116 and 117.

From the previous description, it will be recognized that slicing machine 50 provides loaf feed means for advancing food loaves along each of the two loaf paths based on supports 116-118. There are independent drives or feed means for each of the loaf paths. One such feed means and its associated drive are shown in Figs. 7A and 7B, with some components shown in greater detail in Figs. 8 and 9. These mechanisms are duplicated for the other, parallel food path; see Fig. 5.

Starting with Fig. 7A, it is seen that gripper 151 is mounted on an extension 597 of carriage 125 by a bracket 381; carriage 125 engages and slides longitudinally along the rotatable shaft 126 and the parallel fixed shaft 128. One preferred construction for a gripper is described in detail below in connection with Figs. 10-12; another gripper construction is described in regard to Fig. 15. To understand basic operation of gripper 151, at this juncture it is sufficient to note that each gripper has a plurality of tines 332 that can be actuated to penetrate and grip one end of a feed loaf supported on members 116-118. Tines 332 can also be released from gripping engagement with the end of the loaf when desired. In Fig. 7A gripper 151 is shown at its home position, ready for use, with its tines 332 retracted.

Carriage 125 is connected to the upper run of a timing belt 334 that extends for the full length of loaf transfer mechanism 75. Timing belt 334 engages an idler sprocket 335 at the right-hand end of the transfer mechanism 75 (Fig. 7A); the timing belt engages a drive sprocket 180 at the other end of the belt (Fig. 7B) adjacent slicing station 66 and its orbiting blade 149.

In addition to gripper 151, each loaf feed means in machine 50 includes two short conveyors, exemplified by conveyors 164 and 166 in Figs. 7B and 8. The lowermost "short" conveyor 164, which is shown in detail section on an enlarged scale in Fig. 9, includes the drive pulley 181 mounted on a drive shaft 337, a first idler 339, and a second idler 341 mounted on a pair of levers 342 (only one shown) affixed to a shaft 346. A wide conveyor belt 343 is entrained around pulleys 181, 339, and 341. Belt 343 is mounted on conveyor 164 with idler pulley 341 in the position 341A. Levers 342 are pivoted clockwise, as indicated by arrow L in Fig. 9, to place belt 343 in tension. Belt 343 may have outwardly projecting "ridges" 344, as shown in Fig. 9, for positive engagement with a food loaf. A support bar 345 is positioned immediately below and supports the upper run 347 of belt 343 to maintain and support upper belt run 347 parallel to and aligned with the top surface of loaf support member 117 (Figs. 7B, 8 and 9).

The other, uppermost, "short" conveyor 166 is similar to but even simpler than the lower conveyor 164. As shown in Fig. 8, the upper "short" conveyor 166 comprises a conveyor belt 351 extending around and engaging the drive pulley 182, which is shown mounted on a shaft 353 (Fig. 8). Shaft 353 is journalled in two support members 354; only one is shown. An elongated idler pulley 355 is rotatably mounted on a shaft 356 that is supported on two levers 357 (only one shown) pivoted on support members 354. Pivotal movement of pulley 355, made possible by its mounting on levers 357, tensions belt 351. The entire "short" conveyor 166 is mounted on the housing 359 of the pneumatic, hydraulic, or electrical linear actuator 167; a pneumatic actuator, continuously energized for downward movement, is used in a preferred construction for the slicing machine. Housing 359 is driven down on its piston or shaft 358 as indicated by arrow M in Fig. 7B. The opposite ends of shaft 358 are affixed to and supported between a pair of frame members 371 and 372 that extend outwardly from a vertical frame member 373 that is positioned between loaf feed mechanism 75 and slicing station 66; see Figs. 7B and 8. The upper "short" conveyor 166 includes a two-piece support bar 375, 376 to keep the lower run of conveyor belt 351 flat; see Fig. 8.

Before food loaves are positioned on the two loaf paths defined by members 116-118 (the food loaves are loaded simultaneously) center barrier 121 is elevated to its feed position 121A, Figs. 7A and 7B, by energizing barrier actuator 302, Fig. 7A. The new food loaves are moved toward the longitudinal center of transfer mechanism 75, where barrier 121 is located, until they contact another loaf guide as described hereinafter. Barrier actuator 302 is then retracted (de-energization may do the job if device 302 has a strong spring return) and barrier 121 moves downwardly to its lower operating position. Barrier 121 is preferably one inch (2.54 cm) wide at maximum; it aligns the two food loaves approximately parallel to each other on their respective food paths, separated from each other by approximately one inch (2.54 cm). This separation is arbitrary, determined by the width of divider 121. The separation required is determined by the spacing between grippers 151 in machine 50.

When a food loaf is first placed on support members 116-118 it may tend to slide down toward slicing station 66; the support members of transfer mechanism 75 are at an angle of 45° as shown in Figs. 1-3. The upper surfaces of the support members preferably have a textured finish to facilitate sliding of the food loaf. Each loaf path is closed off, near the slicing station 66, by a door or gate 377 (Figs. 7B and 8) mounted immediately adjacent frame member 373. Thus, a loaf entering mechanism 75 cannot slide down unexpectedly and prematurely into slicing station 66.

Once a food loaf is positioned on its path, gripper 151 is advanced from its home position (Fig. 7A) in the direction of arrow J (Fig. 7A) until it engages the end of the loaf farthest from slicing head 66. This is done by driving belt 334 to move the gripper carriage 125 in the direction of arrow J (Fig. 7A) until the gripper is blocked by engagement with the end of the food loaf. Where engagement of gripper to loaf occurs is dependent upon the length of the loaf. Food loaves may vary considerably in length, typically two to four feet (61 cm to 102 cm). Machine 50 can accommodate a food loaf of any length from as short as one foot (25 cm) to as long as four feet (102 cm).

When gripper 151 contacts the end of a new loaf, the gripper is energized to actuate its tines 332 to penetrate and clamp onto the loaf end, as described hereinafter. At this juncture belt 334 moves the gripper carriage back a short distance (e.g. 1/4 inch or 0.6 cm); the loaf moves with the gripper. Door 377 (Figs. 7B and 8) of slicing head 66 can now be opened, since the loaf no longer engages the door. The drive for timing belt 334 is again reversed and again advances gripper carriage 125 and gripper 151 in the direction of arrow J, Fig. 7A. Actuator 167 is continuously energized toward movement in a downward direction, engaging the loaf with the top of a shear edge member 501 (Figs. 5 and 8). The short feed conveyor 166 is thus engaged with the top of the loaf; see the phantom loaf outline 390, Fig. 7B. Thus, the two short feed conveyors 166 and 164 engage the top and bottom, respectively, of the end of the loaf moving into the slicing station, toward blade 149; see Fig. 7B and Fig. 8. Both short loaf feed conveyors 164 and 166 are driven at the same speed as timing belt 334, as noted in the description of Fig. 4; the loaf feed conveyor drive pulleys 181 and 182 are the same size as the drive pulley 180 for belt 334. Other techniques to make sure that feed conveyors 164 and 166 operate at the same speed as belt 334 may be used as desired. The speed of conveyor belts 347 and 351 (Fig. 8) and timing drive belt 334 (Fig. 7B) is a principal determinant for the thickness of slices cut from each food loaf by blade 149. The orbital speed of blade 149 is the other principal determining factor for slice thickness. The gripper/loaf speed, selected by the operator and/or by the machine's computer program in conjunction with knife blade orbital speed, determines the weight of the individual slices cut from each food loaf. During slicing, the orbital speed of the knife is preferably kept constant, so that variations of the gripper/loaf speed (belt 334) determine slice thickness and weight.

With continued slicing gripper 151 moves toward slicing station 66, ultimately reaching the end position 151A of Fig. 8 with the gripper carriage in its end position 125A, Fig. 7B. This end position is selected to coincide closely with the end of effective slicing size for the food loaf. The thin remaining butt end of the food loaf usually should not be sliced; it is likely to yield undersized slices.

When gripper 151 reaches its end position 151A, Fig. 8, it is tracked by an encoder (not shown) on servomotor 174, which causes the machine's computer program to stop movement of the loaf toward the slicing station, arrow J in Figs. 7A and 8. The drive for timing belt 334 (and for conveyors 164 and 166) is reversed; gripper carriage 125 and gripper 151 start back toward their home positions shown in Fig. 7A. See arrow K in Fig. 7B. During return movement of gripper 151, door actuator 321, Fig. 7A, is energized to pull on members 332, 323 and 325 and open support door 118; door 118 opens to its alternate position 118A, Fig. 7B. When gripper 151, in its return movement (arrow K, Fig. 7B) reaches a point at which the butt end of the food loaf is located over the discharge gap between loaf supports 116 and 117, exposed by opening of door 118, the gripper is reverse energized to open its tines 332 and allow the butt end of the food loaf to drop down clear of the food path. Gripper 151 continues its return movement to the home position shown in Fig. 7A, door 118 is closed, and a new loaf is moved onto the food loaf path to start a new feed cycle. In machine 50, both grippers 151 may move back up to their home positions at about the same time and two (or more) new food loaves may be loaded into the slicing machine simultaneously at the beginning of each new feed/slicing cycle.

Figs. 10-12 illustrate a low-profile gripper construction 451 that may be utilized for the grippers 151 shown generally in earlier figures. Gripper 451 includes a bracket 381 used to secure the gripper to a carriage extension 597 (see Fig. 7A). Gripper 451 (Figs. 10-12) comprises a central housing or manifold 382 affixed to bracket 381 and closed at one end by a rear end plate 383. The central portion of manifold 382, as shown in Fig. 10, is closed by a front end plate 384.

The center portion of gripper 451, as shown in plan in Fig. 10 and in vertical section in Figs. 11 and 12, includes an actuation air inlet passage 385. Passage 385 is connected to an elbow 386 which in turn is connected to a flexible air line 387. All of the air lines connected to gripper 451 should be flexible and are preferably coiled together; they must follow the gripper along its full movement, a distance in excess of four feet (over 102 cm). This is also true of other gripper constructions. A piston 388 is mounted in the central portion of gripper manifold 382. Piston 388 is provided with a seal 389. At the right-hand end of piston 388, as seen in the drawings, there is an inlet chamber 391 which is quite large in the gripper-actuated views of Figs. 10 and 11 but is thin and small when the gripper is in the unactuated condition shown in Fig. 12.

The left-hand end of piston 388 (Figs. 10-12) is connected to a piston rod 392. The outer end of piston rod 392, the left-hand end as seen in Figs. 10-12, is connected to and supports, in cantilever fashion, a dual rack 396 that engages two gears 397 mounted on shafts 398. The two shafts 398 extend between the arms 399 of a bracket 393 mounted on manifold 382. There is a bushing 394 encompassing the end of piston rod 392 connected to piston 388 (Figs. 10 and 11).

The two shafts 398 that span the arms 399 of bracket 393 also constitute supports for the tines 332A and 332B of gripper mechanism 451. There are two spools 401 and two spools 410; one of each is seen in Fig. 10. One spool 401 is mounted on one end of each shaft 398 and one spool 410 is mounted on the other end of each shaft. One spool 401 and one spool 410 is of integral, one piece construction with each spur gear 397, as shown in Fig. 10. Each spool 401 on the lower shaft 398 supports two tines 332A. There are three like tines 332A mounted on spool 410 on the other end of the lower shaft 398. The spool 401 on the upper shaft 398 supports two tines 332B; two more such tines 332B are affixed to and supported by the spool 410 on the other end of the upper shaft 398. Thus, one side of gripper mechanism 451 has four tines and the other side has five, as shown in Fig. 10.

Each of the tines of gripper mechanism 451 is aligned with an opening 400 in a fixed plate 402 that extends across and is mounted on the ends of the arms 399 of bracket 393; see Figs. 11 and 12. Plate 402 also serves as a stop for a sensor plate 403 that is mounted upon the left-hand, outer end of a piston rod 404, as shown in Fig. 10. The other end of rod 404 is connected to a sensor piston 405 disposed within a chamber 406 in the upper third of manifold 382 as viewed from above in Fig. 10. Chamber 406 is in communication with a vent passage 407. Chamber 406 also communicates with a sensor air outlet 408 that corresponds generally in configuration to the actuation air inlet 385. Outlet 408 is connected to an elbow fitting 409 which is in turn connected to a pressure sensor (not shown) by a flexible air line 411.

Gripper mechanism 451 further comprises a retraction segment 413 which is in the lower third of manifold 382 as seen in Fig. 10. In this portion 413 of manifold 382 there are two air passages 414 and 415, connected in series, that lead to a retraction air inlet 416. Retraction air inlet 416 is incorporated in rear end plate 383 and may have the same configuration as the previously described actuation inlet 385 (Figs. 11 and 12). Retraction air inlet 416, as shown in Fig. 10, is connected to an elbow 417. Fitting 417 is like the previously identified elbows 386 and 409 except that in this instance a female fitting is utilized instead of a male fitting to avoid possible erroneous air connections. Elbow 417 is connected to one end of a flexible air line 418.

In considering the operation of gripper 451, in the construction shown in Figs. 10-12, at the outset sensor plate 403 is in the extended position 403A of Fig. 10. With the sensor plate in that position, passage 407 is open and vents chamber 406 in manifold 382 to the atmosphere. The pressure sensor (not shown) connected to line 411 recognizes that chamber 406 is at atmospheric pressure and this condition is signalled to the computer that controls slicing machine 50.

As previously described in connection with Figs. 7-9, gripper 451, when substituted for gripper 151, is moved along its food path in the direction of arrow J until it comes into engagement with the end of a food loaf; the loaf end is represented in Figs. 10-12 by phantom outline 409. Engagement of the gripper with the butt end of the food loaf forces the sensor plate from its original position 403A (Fig. 10) to the position 403 of Figs. 10-12. At this juncture, the internal operating components in the center portion of manifold 382 are in their unactuated operating positions as illustrated in Fig. 12. That is, gripper 451 has not yet been actuated. Movement of the sensor plate to its position 403 drives piston rod 404 to the right, opposite arrow J, to the position illustrated in Fig. 10. As a consequence, sensor piston 405 closes off vent 407 and produces an elevated pressure condition in the outlet 408, 409 and the line 411 connected to the pressure sensor. This change in pressure, identified by the movements of sensor plate 403A, rod 404, and piston 405, is used to initiate actuation of gripper 451 from the unactuated condition shown in Fig. 12 to the actuated condition shown in Figs. 10 and 11. Air is now supplied under pressure to the center portion of manifold 382 through line 387, as indicated by arrow N in Figs. 10 and 11, and effects this change.

Air entering gripper 451 under pressure, as indicated by arrow N, through line 387, increases the pressure within inlet 385 and inlet chamber 391, driving piston 388 to the left to the position shown in Figs. 10 and 11. As a consequence, piston rod 392 and rack 396 move to the left, in the direction of arrow J, from the unactuated position shown in Fig. 12 to the actuated, clamping position shown in Figs. 10 and 11. The movement of rack 396 rotates gears 397 and their integral spools 401 and 410 so that tines 332A rotate in a counter-clockwise direction and tines 332B rotate in a clockwise direction from the positions shown in Fig. 12 to those shown in Figs. 10 and 11. Accordingly, the tines of the gripper penetrate and clamp the end 409 of the new food loaf as illustrated in Figs. 10 and 11. This actuated condition for gripper 451, Figs. 10 and 11, is maintained throughout the time that the food loaf is being sliced.

When slicing of the food loaf is carried as far as possible, and gripper 451 reaches the limit position indicated by phantom outline 151A in Fig. 8, forward motion of the gripper in the direction of arrow J is stopped. The gripper 451 (and the other gripper in machine 50) is then retracted. When the grippers are over door 118, the supply of air under pressure through the actuation air inlet line 387 is shut off and air under pressure is introduced into line 418, as indicated by arrow O in Fig. 10. Air under pressure is thus introduced to the left-hand side of piston 388, as shown in Figs. 10 and 11, and drives the piston back to the unactuated position shown in Fig. 12. This retraction operation for gripper 451 occurs at a time when the gripper is moving toward its home position (see gripper 151 in Fig. 7B), coincident with movement of the remaining unsliced butt end of the loaf over the gap in the food loaf path caused by opening of support door 118, as previously described. The resulting return motion of piston 388, rod 392 and rack 396 rotates shafts 398 and the spools 401 and 410, and thus rotates tines 332A and 332B back to the unactuated positions shown in Fig. 12. This withdraws the tines 332A and 332B from the small remaining butt end of the loaf and allows the butt end of the loaf to drop through door 118, clear of the support surface defining the bottom of the food path on which the loaf has been supported (Fig. 7B). With the loaf no longer in engagement with sensor plate 403 of gripper 451, that plate moves back to the position 403A shown in phantom outline in Fig. 10. When gripper 451 reaches its home position, as previously described, it is in unactuated condition (Fig. 12) ready for engagement with a new loaf on its loaf path.

There are two grippers in slicing machine 50; both of them may utilize the low-profile construction 451 illustrated in Figs. 10-12. The two grippers usually open and close at the same time However, they are independently operable to engage each food loaf on their respective sides of the machine and to drive that food loaf through the slicing head 66 in the manner previously described. The low-profile gripper construction of Figs. 10-12 is pneumatically operated; hydraulic or electrical actuation could be employed if desired. The grippers used in slicing machine 50 should always have a height less than the loaves they drive, in order to preclude any gripper engaging either of the short input conveyors 163-166. The low-profile construction illustrated in Figs. 10-12 is quite appropriate to and useful with a variety of food loaves, even relatively thin sides of bacon.

D. Loaf Loading Mechanisms, Figs. 13 and 14

Fig. 13 affords a sectional elevation view of the automated loaf loading mechanism on the near side of slicing machine 50, in a view taken approximately as indicated by line 13-13 in Fig. 7B. Fig. 13 includes many of the same components as shown in Fig. 5, in Fig. 7B, and in other figures of the drawings.

In Fig. 13 loaf loading tray 85 is shown in an operating position to which it is driven by loaf lift mechanism 107 during automated loading of a food loaf into the slicing machine. The upper surface 501 of tray 85, on which two new feed loaves 500 and 502 are supported, has a series of longitudinal drainage depressions 503 that also serve as loaf troughs for small diameter food loaves. The upper surface 501 of tray 85 may be fabricated of textured sheet steel. Loaves 500 and 502 are shown as rectangular loaves having the maximum cross-sectional size acceptable in the slicing machine for slicing of two loaves. In the loaf loading condition shown in Fig. 13, the upper surface 501 of tray 85 is aligned slightly above and inclined slightly downwardly toward the top surface of loaf support 117, on which the new loaves are to end up, on the machine's food loaf paths, in the positions indicated by phantom outline 500A and 502A. The inclination of surface 501 facilitates loading the new loaves into the slicing machine.

In the portion of the automated loaf loading mechanism shown in solid lines in Fig. 13, door 78 is closed, overlapping the top of guard 83. Door 78 supports the operating mechanism for sweep 153, which is suspended from two carriages 154 each mounted on two shafts 155 as shown in Fig. 3; only one carriage 154 and one suspension member 504 are shown in Fig. 13. Door 78 is pivotally mounted on a shaft 505 that runs the length of load mechanism 75 (Figs. 1-3); door 78 is in the position shown in solid lines in Fig. 13 but is pivoted (clockwise in Fig. 13) to an alternate loaf load position 78A during clean-up of machine 50.

Sweep carriage 154, which slides along two shafts 155, is connected to an elongated timing belt 507. At one end, belt 507 engages a drive pulley 508; drive pulley 508 is affixed to a shaft 505. The other, outer end of belt 507 engages an idler pulley 509 on a shaft 511 that is parallel to shaft 505.

At the beginning of an automated loaf loading operation the loaf loading tray 85 is moved up to the position shown in Fig. 13, aligning new loaves 500 and 502 on tray surface 501 with the support 117 on which the loaves rest while being sliced. The drive for pulley 508 and shaft 505 operates to drive the upper run of belt 507 to the left, in Fig. 13, in the direction indicated by arrows P. This moves the lower run of belt 507 toward the center of the slicing machine, to the right as seen in Fig. 13. The belt movement drives carriage 154 and suspension member 504 to the right along shafts 155 and moves sweep 153 toward and past its position 153A, pushing the new loaves 500 and 502 into the slicing machine until the movement of loaf 502 is interrupted at position 502A with that loaf engaging a guide at position 513A at the opposite side of the machine. While this loaf loading operation is going forward, the center barrier 121 is elevated, clear of the loaf paths to its position 121A. Thus, the two new loaves 500 and 502 are in contact with each other, as shown on tray 85 in Fig. 13, during this part of the loading cycle.

At this point in the automated loaf loading cycle, sweep 153 is backed off to the left, as seen in Fig. 13, and the center barrier 121 is driven down from its elevated position 121A to position 121 between the two new loaves. The downward movement of barrier 121 drives one loaf to position 500A on the left-hand food loaf path; the loaf in position 502A is already aligned on the right-hand food loaf path. The grippers of the slicing machine are now moved down the loaf paths into engagement with the two new food loaves and barrier 121 is again elevated to position 121A where it is clear of the air lines that are connected to the grippers. This completes the automated loaf loading operation.

Fig. 14 is a cross-sectional view of the manual food loaf loading mechanism on the far side of slicing machine 50, as shown in Figs. 1-3. Fig. 14 is taken approximately on the same plane as Fig. 13. It includes a stationary loaf storage tray 515 supporting two new food loaves in positions 500B and 502B, ready to be loaded into the slicing machine.

The manual loading mechanism of the slicing machine, Fig. 14, includes the manual loaf door 79, which is mounted on a rotatable shaft 515 that is parallel to shaft 505. During slicing, door 79 is closed, in the position shown in solid lines in Fig. 14. At the beginning of a manual feed cycle, however, door 79 is pivoted to its alternate operating position 79A. With the door in position 79A, the manual guide 513 is in position 513X, where it does not and cannot interfere with manual loading of new loaves into the slicing machine.

At this point in the manual loaf loading operation, the machine operator moves one loaf from support tray 515 to position 500A on loaf support 117, engaging the automated-side sweep 153 in its position 153A. The machine operator then moves the other new loaf from support 515 to approximately position 502A. It is not necessary for the operator to align the new food loaves precisely on the food loaf paths; at this juncture in the manual loaf loading operation the door is manually pivoted from its open position 79A to its closed position 79, pivoting the manual side guide from its elevated position 513X to its position 513A. Moreover, the center barrier is driven down from its elevated position 121A to its position 121, accurately aligning the new food loaves on the food paths on support 117 (and its related supports 116 and 118, Figs. 7A and 7B). From this point on the manual loaf loading operation is essentially the same as the automated loaf loading operation described above (Fig. 13), with the grippers engaging the new food loaves and barrier 121 returning to its elevated operating position 121A clear of the food loaves.

In Figs. 13 and 14 the end positions for sweep 153A and guide 513A are shown as they would be for slicing two rectangular loaves of the maximum size acceptable in the slicing machine when slicing two loaves. The food loaves to be sliced are frequently smaller in cross-section, and may be round; see outlines 500C and 502C in Fig. 14. Sweeps 153 and 513 must be adjustable, as to their final positions, to accommodate the smaller loaves. On the manual side of the loaf feed mechanism 75, this adjustment is made by mounting the guide on a normally horizontal guide shaft 521. A manual adjustment 522 allows for movement of the guide to any location between two limit positions 513A and 513B to accommodate loaves of different sizes. There are two such adjustments 522 (see Fig. 3); only one appears in Fig. 14. A similar adjustment, for the sweep 153 in the automated loaf feed, adjusting the end position for that sweep between limits 153A and 153B, Fig. 14, is provided.

E. Miscellaneous Figs. 15 and 16

Fig. 15 is a perspective view of a loaf gripper 751 having a construction like that shown generally in Figs. 3 and 7A. As shown in Fig. 15, gripper 751 comprises a manifold 682 closed at its rear (right-hand) end by a plate 683 in which there are three bores 685, 708 and 716. Plate 683 is affixed to a mounting base 681 for mounting the gripper on a horizontal arm 597 of a gripper carriage 125; see Fig. 5.

Within manifold 682, Fig. 15, there is a chamber 691 for a piston 688; chamber 691 is connected to bore 685 in plate 683. Piston 688 has an operating rod 692 that projects through an opening in a rectangular bracket or frame 693 having opposed sides 699 and an outer end plate 702. The outer end of piston rod 692 is operatively connected to a series of upper tines 732A and a corresponding series of lower tines 732B; the operational connection (not shown) may be the same as or similar to the connection between piston rod 392 and tines 332A and 332B in the gripper 451 shown in Figs. 10-12. Each of the tines 732A and 732B is aligned with a slot 700 in plate 702. As seen in Fig. 15, tines 732A and 732B are in their actuated, loaf-gripping positions.

Gripper 751, Fig. 15, further includes a loaf sensor bar 703 mounted on the outer end of a sensor rod 704 connected to a piston 706 in an air pressure chamber in manifold 682. The chamber for piston 706 has a lateral vent 707 to the atmosphere and also is connected to bore 708 in closure plate 683, to allow for connection to an air pressure sensor (not shown). The remaining bore 716 in the end plate 683 of manifold 682 is connected to the front end of piston 688 by passages not illustrated.

Operation of gripper 751, Fig. 15, is essentially the same as previously described for gripper 451, Figs. 10-12. Accordingly, that description need not be repeated. The principal difference between the two grippers is that gripper 451 (Figs. 10-12) has a lower profile than gripper 751 (Fig. 15) and hence may be desirable for food loaves of small cross section or for slicing thin food products such as bacon slabs.

Fig. 16 illustrates three typical loaf cross-section outlines L1, L2, and L3 that may be sliced in slicing machine 50. The two outlines L1 are illustrative of rectangular loaves approximately four inches (102 mm) in height by six and one-half inches (165 mm) in width. Generally comparable round loaves, illustrated by the two outlines L2, are five and one-half inches (140 mm) in diameter. The single centrally located loaf outline L3 has a diameter of six inches (152 mm). To slice all three effectively, with a knife blade edge that traverses a path P in each slicing cycle, it is desirable to provide a range R of about 1.31 inches (33 mm) for adjustment of the height of the support 117 at the end of the loaf paths that enters the slicing station of the machine. Thus, by providing for adjustment of the height of the lower end of the loaf feed mechanism, at the entrance to the slicing station, a wide variety of food loaf sizes and configurations can be accommodated without modification or adjustment of the slicing station mechanism.

In slicing machine 50, although many of the various rotary and linear actuators could be hydraulically actuated, pneumatic actuation is preferred. This minimizes possible contamination of the output of the slicing machine that could arise from a break in a hydraulic line. Of course, for some of the rotary actuators, such as those that drive the slicing station mechanism, electrical servo motors are desirable.

F. The Shear Edge Members And Adjustments, Figs. 17-23.

Figs. 17-23 afford orthagonal views of the shear edge member 501 used to feed two food loaves 502 and 503 into the slicing station; Fig. 17 affords a plan view of the shear edge member, Fig. 18 is an end view, and Fig. 19 is a front elevation view. In machine 50, all of these views would be rotated about 45° because the food loaves enter the slicing station at an angle of approximately 45°.

Shear edge member 501 has a main body 801 formed of a generally rectangular block of a plastic such as nylon. The longest dimension of body 801 is its bottom surface 802 (Figs. 18 and 19); typically, the overall length of bottom wall 802 is about 13.5 inches (34 cm). The overall height of the plastic block 801 is about 3.5 inches (9 cm). There are two square food loaf openings 803 and 804 to receive food loaves 503 and 502, respectively; see Figs. 17 and 19. Openings 803 and 804 each have a width determined by the food loaf size; in this instance the food loaves are about four inches (ten cm) square. But the height of the openings 803 and 804 is smaller than the food loaf height, as can best be seen in Fig. 19. The direction of movement of the food loaves into shear edge member 501 is indicated by arrows L, Figs. 17 and 18.

At the right hand side of shear edge member 501, Figs. 17 and 19, there is a resilient metal guide member 806 that engages the side of food loaf 502. Guide 806 also appears in Fig. 18. A similar resilient metal guide member 807 on the other side of shear edge member 501 engages the side of food loaf 503. A centrally located resilient guide member 808 (Figs. 17 and 19) contacts and guides the adjacent sides of the two food loaves 502 and 503. All of the guides 806-808 may be mounted on the main body 801 of shear edge member 501 by mounting studs 809 or other appropriate means.

The front surface 811 of shear edge member body 801, which projects outwardly from body 801 (see Figs. 17-19) should conform closely to the path P of the cutting edge of the knife blade 149 in slicing station 66. Because there may be some irregularities in the knife blade contour or in its mounting in the slicing station, it may be desirable to trim surface 811 with the knife blade to be certain that conformity is established and maintained. Indeed, it may be desirable to trim surface 811 of the shear edge member after each sharpening of the slicing station knife blade.

Fig. 20 is a front elevation view, like Fig. 19, of a shear edge member 501A used to feed two food loaves 814 and 815 into the slicing station. As in the case of Figs. 17-19, Fig. 20 is actually at an angle, looking upwardly, of 45°, because that is the angle at which food loaves enter the slicing station. Shear edge member 501A has a main body 821 again preferably formed of a block of a machinable resin such as nylon. The longest dimension of body 821 is its bottom 822,

which again may be about 13.5 inches (34 cm). The overall height of the plastic body 821, as shown, is about 3.5 inches (9 cm); it is for use with round loaves 814 and 815 having a diameter of about 3.5 inches, so that the round food loaves each project above their respective openings 824 and 823.

Shear edge member 501A has three resilient metal guide members 806, 807 and 808, aligned and mounted on member 501A in the manner previously described. Guides 806-808 serve the same basic function in shear edge member 501A as in member 501; they guide food loaves 814 and 815 squarely into openings 824 and 823.

Another shear edge member 501B is shown in front elevation, subject to a 45° tilt, in Fig. 21. Member 501B is different from the previously described shear edge members 501 and 501A; it serves just one food loaf 816. Loaf 816 has a diameter of about 3.5 inches (9 cm), like one of the loaves shown in Fig. 11. Loaf 816 is centered in an opening 826 in the body 831 of shear edge member 501B. In this instance there are just the two resilient metal guides 806 and 807, engaging opposite lateral sides of loaf 816.

The knife path P in Figs. 20 and 21 is approximately the same as in Fig. 19; for smaller loaves it may be desirable to adjust the shear edge member down toward path P. For larger loaves, some elevation of the shear edge member (and consequent elevation of the cut face of each food loaf) may be necessary. The mounting for the shear edge members should provide for such vertical adjustment; indeed, the vertical adjustment should apply to the complete loaf feed mechanism 75 adjacent the entry of the food loaves into the slicing mechanism.

There is a shear edge member for each size and shape of food loaf sliced in slicing station 66. Food loaves are most commonly cut in pairs, in machine 50 (Figs. 1-3) but if only one loaf is to be cut, the machine must be equipped with a shear edge member for one loaf of that particular size and shape; see Fig. 21. Alignment of the food loaves with knife 149 and its cutting path P in slicing station 66 (Figs. 3, 4A and 4B) is assured by metal guides 806-808, Figs. 8-12; a skewed food loaf would result in poor slices and would almost certainly be out of the permissible weight tolerance range. In all of the shear edge members (those shown in Figs. 17-19 are merely exemplary) each loaf is engaged on three sides, left, right and bottom, by the shear edge member and its resilient guides. The top of each loaf is held down by the "short" conveyors 165 and 166, Fig. 3. Alignment of the food loaves at the point of slicing, by blade 149, is thus assured.

Figs. 22 and 23 show a shear edge adjustment mechanism 840 used to adjust a shear edge member (e.g., the member 501) toward and away from the path P of the slicing knife blade. Such adjustment is essential to effective operation of the slicing station, to assure clean and accurate cutting of the food loaf slices. Fig. 22 shows shear edge member 501 in a plan view like Fig. 17. Mechanism 840 must move shear edge member 501 smoothly and precisely in the direction of arrows L, the feed direction for food loaves 502 and 503. Canting of shear edge member 501 relative to knife path P is not acceptable, nor is any binding of the adjustment mechanism allowable.

Adjustment mechanism 840, as shown in Fig. 22, is mounted on a support member 841 that extends between two fixed frame members 842. Mechanism 840 includes two pressure blocks 843 mounted on support 841 near opposite ends of the support. Each block 843 is engaged by the end of one of two adjustment shafts 844 threaded through and projecting from a yoke or base 845 and extending through a housing 846 (Figs. 22 and 23) that is mounted on yoke 845. Within housing 846 each shaft 844 is affixed to a pulley 847; see Fig. 23. Pulleys 847 are each engaged by a timing belt 848.

At the center of adjustment mechanism 840 there is a position-locking shaft 849 threaded into the relatively thick base (yoke) 845 for the housing of adjustment mechanism 840. Shaft 849 engages support member 841. At the opposite ends of base yoke 845 there are two shear edge supports 852 that project from the base parallel to the direction of loaf movement (arrows L). The shear edge member, in this instance member 501, is mounted on and spans the ends of supports 852 opposite base 845 of mechanism 840.

When it becomes expedient to adjust the position of a shear edge member (e.g., member 501) in the direction of arrows L, Fig. 22, the knob 859 on shaft 849 is first turned to release shaft 849 from engagement with the lower yoke 841. One of the adjustment knobs 854 on shafts 844 is then turned to move base 845 toward or away from path P, in the direction of arrows L. Most adjustments are toward path P; occasionally, however, an adjustment away from path P, usually a relatively large movement, occasioned by replacement of the knife blade, is required. Turning knob 854 on one positioning shaft 844 turns the other positioning shaft, due to the timing belt 848 and its engagement with pulleys 847; see Fig. 23. Thus, the entire mechanism 840 moves toward or away from cutting path P; there is and can be no twisting or canting of the mechanism. The shear edge member 501 moves with mechanism 840; it is thus quickly and accurately realigned with path P. When adjustment is complete, knob 859 is again used, this time to tighten shaft 849 against yoke 841 and thus immobilize mechanism 840 with the shear edge member in its new position.

G. The Slicing Station Seal, Figs. 24-26

Fig. 24 is a schematic sectional plan view of a portion of a slicing station 866 constructed in accordance with the invention. Figs. 24-26 illustrate a seal that prevents entry of hot water, steam, or other fluids into contact with operating components of the slicing station during clean-up of the slicing machine, as is required at least daily. It will be understood

that the previously discussed slicing station 66 of slicing machine 50 incorporates the sealing features of slicing station 866 shown schematically in Fig. 24.

As shown in Fig. 24, slicing station 866 includes a U-shaped housing 865 closed off on one side by a further housing member 863. Housing member 863 has a relatively large opening which the spindle or head 868 for slicing station 866 fills. Spindle 868 corresponds essentially to the previously described spindle or head 148 (Fig. 4A); it may be driven by a timing belt 190 that is in turn driven from a servo motor 171 through a shaft 171A and a pulley 171B. Slicing station 866 includes a circular knife blade 869 mounted on a shaft 869A journalled in an appropriate bearing in head 868 that is eccentrically located with respect to the axis of head 868. Blade 869 corresponds in all respects to the previously described slicing knife blade 149. It is driven by a pair of timing belts 191 which, in turn, are driven by motor 172 through a shaft 172A and two spindles 172B and 195. Thus, it will be recognized that the knife blade drive for slicing station 866 of Fig. 24 is essentially the same as described above for slicing station 66; see Fig. 4A. A counterweight 868A is mounted on spindle 868 to compensate for the eccentric mounting of blade 869. A small marker 901 is mounted on the periphery of spindle 868 in slicing station 866, Fig. 24. Thus, marker 901 is mounted on a part of the knife blade drive that moves with knife blade 869 as that blade traverses its cutting path P. Marker 901, in its simplest form, may constitute a permanent magnet. A light source (e.g., a LED) or other such emitter can be used for marker 901 if desired. A sensor 902 is mounted upon the housing member 863 in position to sense the presence of marker 901 at one predetermined location indicative of alignment of knife blade 869 at a home position on its cutting path P. That home position is the position illustrated in Fig. 24. Of course, if marker 901 is a light source, sensor 902 should be some form of photodetector. For any position other than the home position, marker 901 and sensor 902 are out of alignment with each other. Stated differently, these two elements are in alignment with each other only when knife blade 869 is in its predetermined home position, determined by the rotational orientation of head 868.

As best shown in Fig. 25, the orbiting head or spindle 868 is provided with a slot or groove 851 that extends around its periphery. A resilient elastomer ring 864 is mounted in slot 851 An ordinary rubber or synthetic elastomer "O" ring is suitable. Other cross-sectional configurations for ring 864 may be employed. In the normal non-sealing position shown in Fig. 25, O-ring 864 blocks a passage 871 that connects to a passage 870 in a member 872 when spindle 868 is in its home position. Passage 870, in turn, is connected to a valve 873 in a compressed air line 874. In Fig. 25, the components, particularly O-ring 864, are shown in the positions that they occupy with valve 873 closed. In Fig. 26, however, it is assumed that valve 873 is open to supply air under pressure through passageways 870 and 871 to impinge upon the interior of O-ring 864 in groove 851. In these circumstances, O-ring 864 is pushed outwardly against the rim of frame member 863, effectively sealing the periphery of spindle head 868 so that no water or steam can enter the interior of housing 865 (Fig. 24).

When a slicing run has finished, in the operation of a slicing machine in which station 866 (Figs. 24-26) is incorporated, a clean-up operation is necessary. At this point, the slicing machine is shut down. Motor 171 may be briefly energized or jogged to turn spindle 868 slowly until marker 901 is approximately aligned with sensor 902. Thereafter, the manual adjustment mechanism for rotation of spindle 868, shown as the large knob 161 at the right-hand side of station 866, is used to rotate spindle 868 until members 901 and 902 are accurately and precisely aligned. This is the home position for spindle 868 and for the knife blade 869 of slicing station 866.

With slicing station 866 in its home position orientation, as shown in Fig. 24, the passage 870 through member 872 (Figs. 25 and 26) is aligned with the passage 871 in the periphery of spindle 868. Initially, there is no seal because valve 873 is closed; the condition is as shown in Fig. 16. However, since the home position for the slicing station has been achieved, valve 873 is now opened to introduce air under pressure into the back of the groove 851 containing O-ring 864, on the side of O-ring 864 opposite frame member 863. As a consequence, the O-ring is driven against frame member 863 and seals off the interior of the housing of slicing station 866, as shown in Fig. 26. As long as this sealed condition is maintained, hot water, soap, and steam cannot enter slicing station housing 865. As a consequence, materially increased working life can be anticipated for the drive components in the slicing station housing.

<u>H. The Blade Honing Mechanism, Figs. 27, 27A, and 28</u>

Figs. 27 and 28 illustrate a blade honing or sharpening device 920 used with the slicing station of the present invention; Fig. 27A is a simplified schematic circuit diagram used to explain one aspect of operation of the honing device. In considering Figs. 27, 27A and 28, it should be assumed that the blade 869 (or 149) of the slicing station 866 (or 66) has been located in its predetermined home position, the position indicated by dash outline 921 in Fig. 27. The blade axis is indicated at 924. This puts the cutting edge of the blade in the position 922 in Fig. 28. One of the other orbital positions for the knife blade is indicated by outline 925.

Honing device 920, Figs. 27 and 29, comprises a housing 923 having an outer surface which should conform in configuration to a part of the wall of the slicing station. Housing 923 includes two mounting devices 931 and 932 (Fig. 27) for mounting housing 923 on the side of the slicing station housing wall 927 (Fig. 28). There is an opening 928 in housing 923, as shown in Fig. 17, that exposes much of the central area of the knife blade in its home position 921. The

peripheral cutting edge of the knife blade, however, is covered by housing 923 except at a second opening 929 in the housing; see Figs. 27 and 28.

The two mounting devices 931 and 932 mount honing device 920 on the slicing station in the desired orientation to the home position 921 of the slicing blade, as shown in Figs. 27 and 28. Device 931, Fig. 27, may be a conventional mounting device; indeed, there may be two or more such mounting devices. Mounting device 932, however, serves an additional purpose. It includes a plunger 933 that extends into alignment with a switch 934, as shown in Fig. 28. The relationship of plunger 933 to switch 934 is such that the switch is actuated from one operating condition to another whenever the plunger is aligned with the switch. That is, mounting of honing device 920 in place on the slicing station housing wall 927 causes switch 934 to be actuated. In the simplified circuit illustrated in Fig. 27A switch 934 is shown as a normally closed device in the energizing circuit for spindle drive motor 171. Switch 934 is opened by mounting device 932 of honing apparatus 920. Consequently, when honing device 920 is in place spindle drive motor 171 cannot be energized; the knife blade remains in its "home" position 921 (Fig. 27). However, the knife blade can be rotated while in its home position because knife blade drive motor 172 can still be energized. It will be recognized that there are other comparable control arrangements for preventing operation of the spindle drive, particularly motor 171, when housing device 920 is in place ready to hone or sharpen the knife blade.

The blade honing or sharpening mechanism 935 of device 920 includes two abrasive honing wheels or stones 936 and 937 which engage opposite sides of blade edge 922. Both are mounted on a carriage 938; a shaft connector 939 projects outwardly from the carriage and can be turned as indicated by arrow N in Fig. 27 to move sharpening mechanism 935 toward or away from the blade to be sharpened.

In use, the honing (sharpening) device 920 is mounted on the slicing station with honing mechanism 935 out of engagement with the blade. This is accomplished using mounting devices 931 and 932; switch 934 (Figs. 27A and 28) is opened by mounting device 932, as described, to assure that the spindle drive motor cannot be activated and that the knife blade will remain in its "home" position 921. The honing mechanism is then advanced to bring honing wheels 936 and 937 into engagement with the cutting edge of the slicing blade, utilizing connector 939. The knife blade drive motor 172 can now be energized, rotating the knife blade, preferably at a slow rate. In this way, the abrasive honing wheels 936 and 937 can hone the entire peripheral cutting edge of the circular knife blade. Although one honing wheel, such as wheel 936, would sharpen the knife blade, it could leave a rough burr on the opposite surface of the knife blade. That is why two honing wheels are preferred. Of course, one honing device 920, of the kind shown in Figs. 27-28, can serve several knife blades in different slicing stations.

I. An Alternate Blade, Fig. 29

Fig. 29 shows a knife blade 949 having an involute cutting edge 950. Blade 949 is rotatable about an axis 951, preferably counterclockwise as indicated by arrow Q. The cutting path for the outermost point on blade 949 is shown by dash line P1; it will be apparent that the entire cutting path is much broader. Alignment of blade 949 relative to food loaves of various sizes and shapes is shown in Fig. 20; the cutting of the food loaves occurs in an arcuate range R, for rotation of blade 949, of about 75° for the largest pair of food loaves illustrated in Fig. 20.

Fig. 29 also shows another position 949A for blade 949 as it rotates about axis 951. Blade position 949A is displaced about 140° from blade position 949; at position 949A the blade does not cut any of the food loaves. The portion of path P1 in which blade 949 does no slicing, even for the largest loaves, is usually about 70°.

Blade 949 has an advantage, as compared with the circular knife blades of previously described slicing stations, in that it does not need an orbiting motion and hence allows for elimination of the spindle and the spindle drive. But blade 949 is not suitable for use with the honing device 920 of Figs. 27 and 28; that honing device is based on a knife blade of constant diameter. However blade 949 can be mounted on a spindle with an O-ring or the like for sealing the slicing head and drive components during clean up; see Figs. 24-26. Other conventional blade configurations can also be utilized in slicing stations incorporating features of the invention.

J. The Method of the Invention, Figs. 30 and 31.

Figs. 30 and 31 are timing charts that illustrate critical functions in the operation of slicing machine 50, in carrying out the method of the invention. Figs. 30 shows the sequence of slicing operations carried out by blade 149 in slicing head 66. Fig. 31 is specifically concerned with the timing of movements, both vertical and horizontal, of receiving conveyor 130, with further scales showing weighing operations and the timing of loaf feed operations. Fig. 30 is also directed to actuation of transfer conveyors 134 and 135 by their actuators 144 and 145 (see Fig. 4B). Fig. 30 further illustrates the timing of operations for scale conveyor 132, along with the related timing of weighing operations, to facilitate correlation of the transfer conveyor operations with those of other portions of the machine.

At the top of Fig. 30 the scale 711 illustrates the cyclic operation of the knife blade in slicing station 66, in this instance the blade 149. Scale 711 starts at time zero, when slicing commences, and shows individual knife blade cycles from the beginning of a slicing operation through the forty-ninth knife cycle. Scale 711 also shows the timing of individual cyclical

movements of blade 149 in its cycles 1,398 through 1,422. Each knife cycle in scale 711 has a predetermined duration that is determined by the computer control for slicing machine 50. That is, the duration of each of the individual knife cycles in scale 711 may vary considerably, depending upon the speed at which knife blade 149 moves orbitally and rotationally. Each knife cycle indicated in scale 711 of Fig. 30 represents a complete orbital movement of knife blade 149 and may include several rotations of the knife blade. For Fig. 30, and also for Fig. 31, it is assumed that there are to be six food loaf slices in each group sliced by machine 50 (see food loaf slice groups 92 and 93 in Figs. 1 and 2). At the right hand end of scale 711, knife cycle 1,406 is assumed to represent the end of slicing operations. At this point one hundred seventy six groups of slices have been cut from the food loaves.

The next scale 712 in Fig. 30 pertains to the individual overall operating cycles of machine 50 as employed in carrying out the method of this invention. These machine cycles are sometimes referred to as "manufacturing cycles". Each includes N knife blade cycles. In Figs. 30 and 31 N=8. Thus, under the assumptions noted above, after six slices have been cut from a food loaf there are two knife cycles (scale 711) in which no slicing occurs. These non-slicing cycles enable the machine to discharge a slice group from the receiving conveyor 130 to the next part of the classifier/conveyor system 64 (deceleration conveyor 131 in Fig. 4B). In this same time interval the slicing machine is again conditioned for cutting a new slice group. Consequently, and as indicated by scale 712 in Fig. 30, for the assumed conditions each of the machine (manufacturing) cycles 1001-1006, 1176 and 1177 corresponds to eight cycles of knife blade 149 in slicing station 66, scale 711.

The intervals 1180 when slicing actually occurs are as shown in the third scale 713 of Fig. 30. That is, in each machine cycle, scale 712, in the first six cycles of the knife blade 149 a new slice is cut from the meat loaf; actually, two slices are cut in each knife blade cycle if, as usual, two loaves are sliced simultaneously. Thus, X=6. In the next two knife cycles within each machine cycle, however, there is no slicing operation. Instead, the slice groups already cut are transferred from receiving conveyor 130 to deceleration conveyor 131 (Fig. 4B) and receiving conveyor 130 is restored to its initial operating condition to receive the next group of slices.

The next scale 714 in Fig. 30 relates to the timing of operation of scale conveyor 132 and its vertical actuator 143. At some point in each manufacturing cycle, in this instance a point assumed to correspond to the end of the third knife cycle, actuator 143 pulls the outer (left-hand) end of scale conveyor 132 down (Fig. 4B) so that any group of slices on conveyor 132 is deposited on one of the scale grids 141 and 142, as previously described. In the first machine cycle 1001 there is no group of slices on scale conveyor 132 so that its actuator 143 lifts conveyor 132 to its "reject" level; no weighing operation occurs. This is also true during the second manufacturing cycle 1002; see scales 712 and 724. By the time the third machine cycle 1003 has begun and slicing of the food loaves is resumed for a third time, one (or two) group of food loaf slices is present on scale conveyor 132. Thus, in the third slicing interval, during machine cycle 1003 (scales 712 and 713 of Fig. 30) weighing does take place during the time interval that actuator 143 has pulled conveyor 132 down so that the groups of food loaf slices are supported upon the scale grids; see scale 724. Thereafter, in each cycle of machine operation, any groups of slices present on scale conveyor 132 are weighed.

For Fig. 30, it has been assumed that conveyor/classifier system 64 advances the food loaf groups in the direction of arrow A (Fig. 4B) at the same rate that they are cut and that weighing of the slice groups occurs during a single knife cycle, the sixth cycle in each slicing interval. However, this is not necessarily the case; the slice group weighing operation at conveyor 132, scale 724, may require a longer interval than one knife cycle or it may be completed in a shorter time, depending upon the speed of operation of actuator 143. The two time requirements are independent of each other. Of course, weighing of slice groups should be continued after slicing has been finished so that the last few groups of food loaf slices will be weighed. That is why, at the right hand side of Fig. 30, the weighing intervals (scale 724) continue after slicing ends with cycle 1,406 of blade 149.

In carrying out the preferred method of the invention each group of slices is weighed to determine whether the group comes within pre-set tolerance limits. It is also important that the integrity of the weighing operation be maintained. To this end, a zero or "tare" weight is determined for each load cell 198 and 199 (Fig. 4B) in each machine cycle. As shown by scale 725 in Fig. 30, this is carried out, in part, by taking a zero weight measurement in each machine cycle. The zero weight determination made in each cycle is subtracted from the gross stack weight measured shortly thereafter, in the same cycle; see scale 724 in Fig. 30. Thus, if the total weight of one weighing grid changes, as when a small portion of food loaf material or some other item of debris clings to the grid, while slicing is going forward, that excess weight is included in the "zero" weighing step and does not result in a false weight determination for succeeding stacks. By the same token, if the excess material is subsequently dislodged from the grid, later zero weight measurements reflect the change; the weighing of subsequent slice groups is still accurate.

In Fig. 31 the uppermost scale 711A corresponds to eighteen cycles of knife 149, from scale 711 in Fig. 30, occurring in machine cycles 1004-1006, scale 712A. As slicing begins, near the beginning of machine cycle 1004 at the left hand side of Fig. 30, receiving conveyor 130 is restored to its uppermost position at point 799 and then begins to move vertically downwardly at a relatively slow rate, as indicated by curve 756. This downward movement is continued during the first six knife blade cycles in machine cycle 1004, while slices are cut from the loaves being fed into the slicing station in machine 50. At point 726 in Fig. 31, shortly after the end of the sixth knife cycle in machine cycle 1004, the downward movement of receiving conveyor 130 is interrupted and the receiving conveyor is maintained at a constant level by its

lift mechanism 138 (Fig. 4B). At this juncture, receiving conveyor 130 is at approximately the same level as the next adjacent deceleration conveyor 131 (see Fig. 4)B.

Thereafter, starting at point 727 in Fig. 31, before the beginning of the first knife cycle in the next manufacturing cycle 1005, when a new slicing operation begins, receiving conveyor 130 is moved rapidly upwardly to an elevated position (point 728) where it is ready to receive a new food loaf slice, the first slice cut in machine cycle 1005. During the first six (cutting) cycles in machine cycle 1005, after a brief dwell, receiving conveyor 130 again moves downwardly. Following point 718 on curve 756, there is again a dwell, extending to point 719, during which there is no vertical movement of receiving conveyor 130. Thereafter, rapid upward movement of the receiving conveyor is again carried out, to point 720, to restore the receiving conveyor to the elevation at which the first slice is received, again following a brief dwell. The upward and downward movements of receiving conveyor 130 are effected by motor 173 and mechanism 138 (Fig. 4B). Each incremental downward movement 721 of receiving conveyor 130 should be approximately the same as the thickness of a slice cut from a food loaf during a given cycle of blade 149 so that the vertical position at which receiving conveyor 130 "catches" a downwardly moving slice is always the same.

As pointed out previously, slicing machine 50 can produce stacked food loaf slices. Curve 757 illustrates one mode of horizontal operation for receiving conveyor 130 when the food loaf slices are to be stacked. In the initial portion 752 of curve 757, extending through the sixth cycle of knife blade 149 in machine cycle 1004, there is no horizontal movement for receiving conveyor 130. That is, during interval 752 motor 176 does not drive the belts of conveyor 130 (Fig. 4B); those belts remain essentially stationary. This is also true of the receiving pins 137 that are on pin wheels interleaved with the belts of conveyor 130 and driven at the same peripheral speed as the belt speed.

During the next interval 753 of curve 757, Fig. 31, while vertical movement of receiving conveyor 130 is interrupted (between points 726 and 727 in curve 756) receiving conveyor 130 is driven forward rapidly by motor 176 and drive mechanism 101 (Fig. 4B) to discharge an accumulated stack of food loaf slices from receiving conveyor 130 to deceleration conveyor 131. This discharge operation must be completed before the receiving conveyor is again elevated to receive the next stack at point 728 in curve 756. During the next interval 754 in curve 757 receiving conveyor 130 again remains essentially stationary as regards horizontal motion; drive motor 176 is quiescent. However, the next time that vertical movement of receiving conveyor 130 is interrupted (after point 718 on curve 756) the receiving conveyor again enters a period 755 (curve 757) when it is driven rapidly forward, in the direction of arrow A (Fig. 4B), to again unload an accumulated stack of food loaf slices onto the next conveyor in system 64, deceleration conveyor 131.

In Fig. 31, curve 758 shows an alternate to curve 757, which may be employed when the groups of food loaf slices are to be stacked as cut. The segments 762, 763, 764, and 765 of curve 758 correspond in timing to the sections 752-755, respectively, of curve 757. In the alternative curve 758, however, during each of the intervals 762 and 764 there is a slow movement of the conveyor in a reverse direction. That is, during these intervals 762 and 764 the belts of conveyor 130 and pins 137 are driven in a direction opposite to arrow A (Fig. 4B). In some instances, this alternate stacking sequence improves the configuration of the stacks, which may tend to become deformed due to lateral forces applied to the slices by the rotating knife blade as the slices are cut.

Curve 759, Fig. 31, illustrates the manner in which the receiving conveyor 130 is driven, for horizontal movement, when the groups of cut food loaf slices are to be shingled rather than stacked. During the first six knife cycles in machine cycle 1004, the initial portion 742 of curve 759, receiving conveyor 130 is driven slowly forward by motor 176 and drive linkage 101 (Fig. 4B). As a consequence, the eight slices cut from the food loaf during interval 742 are shingled rather than stacked on receiving conveyor 130. The first slice falling onto the receiving conveyor impinges upon receiving pins 137, which operate at the same speed as the belts of the conveyor, assisting in the shingling operation. During the next interval 743, however, as in curves 757 and 758, it is necessary to discharge the shingled group of food loaf slices from receiving conveyor 130 onto deceleration conveyor 131. Thus, during the interval 743 of curve 759, pertaining to shingling of the slice groups, receiving conveyor 130 is driven rapidly forward to discharge the shingled group of slices onto deceleration conveyor 131. Thereafter, during interval 744, slow horizontal movement of the receiving conveyor is resumed, again followed by a rapid discharge motion in interval 745.

For consistency of slicing, and to maintain the integrity of the slice groups produced by machine 50, the feeding of food loaves into slicing station 66 (Fig. 4B) is interrupted at the end of the slicing of each group. If this is not done, extraneous slices may be cut, producing highly indeterminate operation of the slicing machine. Furthermore, it is not sufficient simply to stop the food loaf feeding movement into slicing station 66 (Fig. 4B). Rather, it is desirable to clear the food loaves from the slicing station in order to avoid cutting of thin slices or other malfunctions in the slicing operation.

In Fig. 31, the scale 771 shows the timing of operations for the loaf feed provided by motors 174 and motor 175 during operation of the slicing machine. During a first interval 746 approximately coincident with the first six cycles of knife blades 149 in manufacturing cycle 1004, while slices are being cut from the food loaf or food loaves, the loaf feed operates in a forward direction to advance the food loaves into slicing station 66 as previously described. In a substantially shorter interval 747 immediately following this normal loaf feed during interval 746, however, the loaf feed is reversed. This is followed by another brief interval 748 during which loaf feed is stopped. Thus, during the seventh and eighth cycles of knife blade 149 in manufacturing cycle 804 the food loaves are first displaced away from slicing station 66 and its continuously operating knife blade 149 during interval 747, and then loaf feed is interrupted during interval 748.

Thereafter, in an interval 746A, the food loaves are again moved forwardly into the slicing station. This motion continues until the slicing of the next group of food loaves is completed at the end of the sixth cycle of knife blade 149 in the next manufacturing cycle 1005. Food loaf motion is reversed during the next time interval 747A and stopped for a further brief interval 748A, after which forward motion of the food loaves is again resumed.

The reverse movement of the food loaves during intervals 747 and 747A does not occupy the entire time, two knife cycles, during which the cutting operation in slicing station 66 is interrupted to enable the machine to advance one group of slices from the receiving conveyor to the deceleration conveyor and to start cutting the next group of slices. If reverse movement were continued throughout the time that no slices were cut, in this instance two knife blade cycles, the food loaves would not be ready and available for cutting of the next group of slices. Thus, with two non-slicing knife blade cycles interposed between each slicing interval 980 (see scale 703 in Fig. 30) the reverse movement of the loaf feed (Fig. 31) is maintained for only a part of one of the two knife blade cycles and then stopped. Forward movement is resumed in each machine cycle before slicing again begins to bring the meat loaf (or loaves) back to the correct position for resumption of slicing. Fig. 31 includes a curve 714A, like scale 714 in Fig. 30, to aid in correlation of the two timing charts.

Operation of the transfer conveyors 134 and 135 must also be coordinated with other machine operations. Thus, as shown in Fig. 30 by the scale 726, which begins after the twentieth cycle for knife blade 149, each transfer conveyor such as conveyor 134 (Fig. 4B) is usually initially maintained in the elevated reject position by its vertical actuator 144. Actually, when slicing begins the positions of the transfer conveyors are immaterial because there are no food loaf slice groups discharged from the slicing machine as yet. The weighing operation is probably going to show that the first stacks cut (in machine cycle 1001) are light in weight and hence out of tolerance. Thus, in machine cycle 1004 the groups of food loaf slices are likely to be out of tolerance so that the transfer conveyor is maintained in the reject position; see scale 726.

In the next operation of scale conveyor 132, however, in manufacturing cycle 1005, it is far more likely that any slice group on the scale conveyor will weigh in within tolerance. In that circumstance, device 144 is actuated, in response to the weight signal, to shift transfer conveyor 134 down to its in tolerance (accept) position. This makes it possible for the sliced group to be discharged to an "accept" takeaway conveyor (not shown) rather than to a "reject" conveyor. In normal operation of slicing machine 50, thereafter, transfer conveyor 134 is held down because the sliced group are usually within the preset weight tolerance. The operation of transfer conveyor 134 illustrated by curve 726 in Fig. 30 is also typical of the other transfer conveyor 135 and its vertical actuator 145; see Fig. 4B.

From Figs. 30 and 31, and the previous description of slicing machine 50, it will be apparent that each machine cycle includes a given number (N) of knife blade cycles but that cutting actually occurs in only a smaller number (X) of knife blade cycles. See Fig. 30. The numbers N and X change, depending upon the food loaf or loaves being sliced, the quantity of slices in each group, and like factors. However, X is always smaller than N. In the example on which Figs. 30 and 31 are based, N=8 and X=6. But the relationships do not change; during each of X knife blade cycles slices are cut from the loaves fed into the slicing station of the machine, but during the balance (N-X) of each manufacturing cycle the slice groups are discharged from receiving conveyor 130 to deceleration conveyor 131 and the loaf feed drive is reversed twice; see curve 771, Fig. 31.

In each manufacturing cycle scale conveyor 132 is moved down and then back up by its actuator 143 (Fig. 4B) to weigh any slice groups on the scale conveyor; see curve 714 in Fig. 30 and curve 714A in Fig. 31. The weighing at scale conveyor 132 controls the positions of transfer conveyors 134 and 135; see curve 726 in Fig. 30. A further weighing operation can be effected by incorporating one or two scales in the receiving conveyor 130; see grid 136 in Fig. 3. In this arrangement each slice group is weighed twice, once at conveyor 130 and again at conveyor 132. A dual weighing system of this kind is sometimes desirable, as in bacon slicing operations. When an initial weighing operation is carried out at receiving conveyor 130, the groups of food loaf slices are accumulated on the weighing grid rather than on the conveyor. In this situation curve 756 of Fig. 31 applies to the receiving weighing grid, not to conveyor 130.

In a typical slicing machine utilizing the method of the present invention, each knife blade cutting cycle (scale 711A, Fig. 31) starts at about 95° in the orbital cycle of the knife blade, the rotational cycle of head 148 (Figs. 3 and 4B). The end of the cutting cycle coincides approximately with an orbital position of about 195°. As previously noted, the knife cutting cycle is determined by orbital speed of the knife blade in the described slicing machine; the knife cycle is not dependent on the rotational speed of the knife blade. In a slicing machine using a contoured knife blade (Fig. 29), with only rotational movement (no orbit), this does not apply; the rotational speed of the knife blade then determines the duration of the knife cycles.

To afford a more comprehensive example of the present invention, the durations of several steps depicted in Figs. 30 and 31 and the speeds of several conveyors are presented in Table I. It should be understood that these are given as typical only for a given food loaf slicing situation; all of these numbers may and will change for different numbers of slices in slice groups, different food loaf feed rates and slice thicknesses, and numerous other factors.

TABLE I (EXEMPLARY ONLY)
(Fig. 31)

Operation	Time
W, knife blade cycle (711A)	80 milliseconds
Weighing intervals (714A)	48 milliseconds
Scale conveyor 132 down (714A)	75 milliseconds
Scale conveyor 132 up (714A)	185 milliseconds
Scale conveyor 132 dwell (down) (714A)	135 milliseconds
Transfer conveyor 134 or 135, up or down (727)	335 milliseconds
Receiving conveyor 130, fast forward	120 milliseconds
Reverse loaf feed and restore loaf feed (771)	40 milliseconds
Stop loaf feed (771)	80 milliseconds

Conveyors	Speed
130 fast forward (757-759)	325 feet/min.
131, 132, 134, 135	105 feet/min.

Claims

1. An improved high speed food loaf slicing machine comprising a slicing station including a knife blade and a knife blade drive driving the knife blade along a predetermined cutting path, and loaf support means for supporting a first food loaf and a second food loaf for movement along parallel first and second loaf paths, respectively, into the slicing station for repetitive slicing of both loaves by the knife blade,

   the improvement comprising:

   a first loaf feed drive for advancing the first food loaf along the first loaf path at a first preselected loaf feed rate;

   a second loaf feed drive for advancing the second food loaf along the second loaf path at a second preselected loaf feed rate;

   and means for varying one loaf feed rate independently of the other so that slices cut from one loaf can differ in thickness from slices cut from the other.

2. An improved high speed food loaf slicing machine according to Claim 1, in which each loaf feed drive includes two short feed conveyors engaging opposite sides of a food loaf immediately ahead of the slicing station.

3. An improved high speed food loaf slicing machine according to Claim 2, in which:

   each loaf feed drive includes a gripper releasably gripping an end of a food loaf, on the associated food path, remote from the slicing station; and

   gripper drive means for driving the gripper along its loaf path toward the slicing station at the same speed as the two short feed conveyors associated with that food path.

4. An improved high speed food loaf slicing machine according to Claim 2, in which the improvement further comprises:
an elongated sweep parallel to the first loaf path and in spaced parallel relation to the barrier;
and sweep drive means, connected to the sweep, for displacing the sweep between a first sweep position in which the sweep engages one side of a food loaf, displaced from the barrier, on a loaf path, and a second sweep position clear of the loaf paths.

5. An improved high speed food loaf slicing machine comprising a slicing station including a knife blade and a knife blade drive driving the knife blade along a predetermined cutting path, and loaf support means for supporting a first food loaf and a second food loaf for movement along parallel first and second loaf paths, respectively, into the slicing station for repetitive slicing of both loaves by the knife blade,
the improvement comprising:
a first loaf storage tray for storing a food loaf ready for transfer to a loaf path; and
first loaf transfer means for moving a food loaf from the first loaf storage tray to a loaf path.

6. An improved high speed food loaf slicing machine according to Claim 1 or 5 in which the first loaf storage tray has a textured upper surface on which the food loaf is stored.

7. An improved high speed food loaf slicing machine according to Claim 1 or 5, in which the first loaf storage tray and the first loaf transfer means are located on one side of the slicing machine, the improvement further comprising:
a second loaf storage tray for storing a food loaf ready for transfer to a loaf path; and
second loaf transfer means for moving a food loaf from the second loaf storage tray to a loaf path;
the second loaf storage tray and second loaf transfer means being located on the opposite side of the slicing machine from the first loaf storage tray and the first loaf transfer means.

8. An improved high speed food loaf slicing machine according to Claim 1 or 5, in which the first loaf storage tray and the first loaf transfer means constitute an automated loaf loading mechanism, located on one side of the slicing machine, the improvement further comprising:
a manual loaf loading mechanism located at the opposite side of the machine from the automated loaf loading mechanism, the manual loaf loading mechanism including a cover for the second loaf path and means for raising that cover upon completion of slicing of a food loaf on the second loaf path.

9. An improved high speed food loaf slicing machine comprising a slicing station including a knife blade and a knife blade drive driving the knife blade along a predetermined cutting path, and loaf support means for supporting a first food loaf and a second food loaf for movement along parallel first and second loaf paths, respectively, into the slicing station for repetitive slicing of both loaves by the knife blade,
the improvement comprising:
a first loaf gripper, on the first loaf path, actuatable between a gripping condition, in which the first gripper engages and grips the end of the first food loaf remote from the slicing station, on the first loaf path, and a release condition disengaged from the first loaf; and
a second loaf gripper, on the second loaf path, actuatable between a gripping condition gripping a second food loaf and a release condition;
the first and second grippers being actuatable independently of each other.

10. An improved high speed food loaf slicing machine comprising a slicing station including a knife blade and a knife blade drive driving the knife blade along a predetermined cutting path, and loaf support means for supporting a first food loaf and a second food loaf for movement along parallel first and second loaf paths, respectively, into the slicing station for repetitive slicing of both loaves by the knife blade,
the improvement comprising:
an elongated barrier aligned between and parallel to the first and second loaf paths; and
barrier displacement means for displacing the barrier between a first position between food loaves on the food paths and a second position clear of food loaves on the food paths.

11. An improved high speed food loaf slicing machine comprising a slicing station including a knife blade and a knife blade drive driving the knife blade along a predetermined cutting path, and loaf support means for supporting a first food loaf and a second food loaf for movement along parallel first and second loaf paths, respectively, into the slicing station for repetitive slicing of both loaves by the knife blade,
the improvement comprising:
a first pair of short feed conveyors engaging opposite sides of a first food loaf along the portion of the first loaf path immediately adjacent the slicing station; and

a second pair of short feed conveyors engaging opposite sides of a second food loaf along the portion of the second loaf path immediately adjacent the slicing station.

12. An improved high speed food loaf slicing machine according to Claim 11, in which the improvement further comprises:
two grippers, one on each food path, each gripper releasably gripping a food loaf at the end of that food loaf remote from the slicing station; and
means for driving each gripper along its loaf path at the same speed as the two short feed conveyors associated with that food path.

13. An improved high speed food loaf slicing machine according to Claim 1 of 12 in which each gripper is driven to a home position at the end of its loaf path remote from the slicing station, by its gripper drive means, prior to the aforesaid movement of the gripper along its loaf path toward the slicing station.

14. An improved high speed food loaf slicing machine according to Claim 1 or 12, in which the improvement further comprises:
a first loaf storage tray for storing a food loaf ready for transfer to a loaf path; and
first loaf transfer means for moving a food loaf from the first loaf storage tray to a loaf path.

15. An improved high speed food loaf slicing machine according to any preceding claim, in which the improvement further comprises:
an elongated barrier aligned between and parallel to the first and second loaf paths; and
barrier displacement means for displacing the barrier between a first position between food loaves on the food paths and a second position clear of food loaves on the food paths.

16. An improved high speed food loaf slicing machine according to any preceding claim, in which the barrier is of V-shaped cross-sectional configuration.

17. An improved high speed food loaf slicing machine according to any preceding claim, in which the improvement further comprises:
an elongated sweep parallel to the first loaf path and in spaced parallel relation to the barrier;
and sweep drive means, connected to the sweep, for displacing the sweep between a first sweep position in which the sweep engages one side of a food loaf, displaced from the barrier, on the first loaf path, and a second sweep position clear of the loaf paths.

18. An improved high speed food loaf slicing machine according to any preceding claim, in which the improvement further comprises:
adjustment means to adjust the end of the loaf support means immediately adjacent the slicing station over a limited vertical range of no more than two inches (five cm) to accommodate food loaves of varying height.

19. An improved high speed food loaf slicing machine according to any preceding claim, in which:
the sweep, in moving from its second sweep position to its first sweep position, first moves to an intermediate sweep position adjacent to but spaced from the first food loaf, and subsequently moves from its intermediate sweep position to its first sweep position.

20. An improved high speed food loaf slicing machine comprising a slicing station including a knife blade and a knife blade drive driving the knife blade along a predetermined cutting path, and loaf support means for supporting a first food loaf and a second food loaf for movement along parallel first and second loaf paths, respectively, into the slicing station for repetitive slicing of both loaves by the knife blade,
the improvement in which:
the loaf support means comprises first and second aligned supports separated from each other, in a direction parallel to the food paths, by a discharge space;
a third support movable between a normal closed position in which the third support fills the discharge space and an open position in which the discharge space is open between the first and second supports;
and actuating means for moving the third support member to its open position following completion of slicing of a food loaf and subsequently returning the third support to its normal closed position.

21. An improved high speed food loaf slicing machine according to Claim 20 in which each of the first, second, and third supports has a textured upper surface constituting the bottom of a portion of the food loaf paths.

22. An improved high speed food loaf slicing machine according to Claim 20 in which the improvement further comprises:
first and second loaf feed drives for advancing food loaves along the first and second loaf paths, respectively; and
the loaf support means is mounted in the slicing machine for movement between a normal support position, in which the loaf support means is inclined upwardly from the slicing station and masks the loaf feed drives, and a cleanup position in which the loaf support means exposes the loaf feed drives for cleanup access.

23. An improved high speed food loaf slicing machine according to Claim 22 in which:
the loaf support means is pivotally mounted, for movement between its normal support position and its cleanup position, along a pivotal axis transverse to the food paths and adjacent the slicing station.

24. An improved high speed food loaf slicing machine according to Claim 22 in which:
each loaf feed drive includes a gripper releasably gripping an end of a food loaf on one associated food path remote from the slicing station, a drive belt driving the gripper from a home position toward the slicing station and back to its home position, and gripper actuation means for actuating the gripper between a loaf gripping condition and a release condition;
the gripper actuation means for each gripper actuating that gripper to its release condition when the gripper passes the discharge space during movement of the gripper to its home position.

25. An improved gripper for a high speed food loaf slicing machine comprising a slicing station including a knife blade drive driving the knife blade along a predetermined cutting path, loaf support means for supporting a food loaf for movement along a loaf path into the slicing station for repetitive slicing by the knife blade, a gripper for gripping the end of a food loaf, on the loaf path, remote from the slicing station, and gripper drive means for driving the gripper along the loaf path toward the slicing station and back, the improved gripper comprising:
a sensor for sensing engagement of the gripper with the end of a food loaf as the gripper moves along the food path toward the slicing station;
at least two gripping elements each actuatable between a loaf end gripping position and a release position;
and a gripping element actuator responsive to the sensor, for actuating the gripping elements to their gripping positions when the sensor senses engagement with the end of a food loaf, and for actuating the gripping elements to their release positions when the gripper moves back along the food path.

26. An improved gripper for a food loaf slicing machine according to Claim 25, in which:
each gripping element comprises a plurality of C-curved pointed gripping tines mounted on a rotatable spool connected to a spur gear;
and the actuator comprises a pneumatic piston having a piston rod affording a rack in meshing engagement with the spur gear.

27. An improved gripper for a food loaf slicing machine according to Claim 26, in which the gripper further comprises a connector engageable with a carriage extension extending transversely of the loaf path.

28. A slicing station for a high speed food loaf slicing machine including food loaf support means defining a food loaf path, loaf feed means for feeding a food loaf along the food loaf path toward a slicing station, and receiving means for collecting and removing groups of food loaf slices cut from the food loaf at the slicing station, the slicing station comprising:
a knife blade movable along a predetermined cutting path through a slicing range intersecting the end of a food loaf on the food loaf path;
a cyclic drive, connected to the knife blade, for driving the knife blade cyclically along its cutting path at a predetermined cycle rate;
a marker, movable with the knife blade as the knife blade moves along its cutting path; and
a sensor, mounted in fixed position in the slicing station, for sensing the presence of the marker at a preselected location indicative of location of the knife blade at a predetermined home position on its cutting path.

29. A slicing station for a high speed food loaf slicing machine including food loaf support means defining a food loaf path, loaf feed means for feeding a food loaf along the food loaf path toward a slicing station, and receiving means for collecting and removing groups of food loaf slices cut from the food loaf at the slicing station, the slicing station comprising:
a slicing station housing;
a knife blade, located outside the housing and movable along a predetermined cutting path through a slicing range intersecting the end of a food loaf on the food loaf path;

a cyclic drive, enclosed within the slicing station housing and connected to the knife blade, for driving the knife blade cyclically along its cutting path at a predetermined cycle rate;

a marker movable with the knife blade as the knife blade moves along its cutting path;

a sensor, mounted in fixed position in the slicing station, for sensing the presence of the marker at a preselected location indicative of location of the knife blade at a home position on its cutting path; and

sealing means, actuatable between a relaxed non-sealing condition and a sealing condition in which the sealing means seals the slicing station housing against entry of fluids into that housing;

the sealing means being actuatable to its sealing condition only when the blade is in its home position.

30. A slicing station for a food loaf slicing machine according to Claim 28 or 29 in which:

the slicing station further comprises a rotatable spindle on which the knife blade is eccentrically mounted;

the rotatable spindle is driven by the cyclic drive so that the knife blade performs an orbital motion at the predetermined cycle rate;

and the marker is mounted on the spindle for rotation therewith.

31. A slicing station for a food loaf slicing machine according to Claim 28 or 30 in which the knife blade is a rotatable blade of circular configuration and in which the slicing station further comprises a knife blade drive for rotating the knife blade.

32. A slicing station for a food loaf slicing machine according to Claim 30 in which the sealing means seals the spindle to the housing.

33. A slicing station for a food loaf slicing machine according to Claim 32 in which the sealing means comprises a resilient O-ring mounted in a groove in the housing, which groove surrounds the periphery of the spindle, and means to apply a fluid under pressure to the sides of the O-ring facing the base of the groove only when the knife blade is in its home position.

34. A slicing station for a food loaf slicing machine according to Claim 33 in which the fluid is compressed air.

35. A slicing station for a high speed food loaf slicing machine including food loaf support means defining a food loaf path, loaf feed means for feeding a food loaf along the food loaf path toward a slicing station, and receiving means for collecting and removing groups of food loaf slices cut from the food loaf at the slicing station, the slicing station comprising:

a slicing station housing;

a circular knife blade, located outside the housing and having a peripheral cutting edge;

a knife blade drive for rotating the knife blade;

a rotatable spindle on which the knife blade is eccentrically mounted for movement of the knife blade cutting edge along a predetermined orbital cutting path through a slicing range intersecting the end of a food loaf on the food loaf path;

a spindle drive for rotating the spindle at a predetermined orbital cycle rate;

a marker, mounted on the spindle for movement therewith;

a sensor for sensing the presence of the marker at a predetermined location indicative of location of the knife blade at a home position on its cutting path;

a honing device, mountable on the housing in engagement with the cutting edge of the knife blade when the knife blade is in its home position;

and blade rotation means to rotate the knife blade without rotating the spindle when the knife blade is in its home position.

36. A slicing station for a food loaf slicing machine according to Claim 35 in which the knife blade drive and the spindle drive are both electrical drives energized from a common source and the blade rotation means is actuated by the honing device.

37. A slicing station for a food loaf slicing machine according to Claim 36 in which the spindle drive includes a drive motor and the blade rotation means includes a switch in series with that drive motor.

38. A slicing station for a food loaf slicing machine according to Claim 35 in which the honing device includes a honing device housing which covers most of the cutting edge of the knife blade when the honing device is mounted on the slicing station housing.

39. A slicing station for a food loaf slicing machine according to Claim 35 in which the honing device comprises two honing wheels engaging opposite sides of the cutting edge of the knife blade.

40. A slicing station for a high speed food loaf slicing machine including food loaf support means defining a food loaf path, loaf feed means for feeding a food loaf along the food loaf path toward a slicing station, and receiving means for collecting and removing groups of food loaf slices cut from the food loaf at the slicing station, the slicing station comprising:

a knife blade movable along a predetermined cutting path through a slicing range intersecting the end of a food loaf on the food loaf path;

a cyclic drive, connected to the knife blade, for driving the knife blade cyclically along its cutting path at a predetermined cycle rate;

a shear edge member for guiding the end of a food loaf from the food loaf path into the cutting path of the knife blade;

and shear edge mounting means for mounting the shear edge member for movement in a predetermined direction toward and away from the knife blade cutting path.

41. A slicing station for a food loaf slicing machine according to Claim 40 in which:

the shear edge member comprises an elongated block having at least one loaf-receiving opening for receiving one end of a food loaf on the food loaf path;

the shear edge mounting means includes an elongated yoke disposed in parallel spaced relation to the shear edge member, and a pair of spaced supports projecting from the yoke into engaging and supporting relation to the shear edge member;

and further comprising shear edge adjustment means, including a plurality of adjustment shafts threaded into the shear edge mounting yoke, for adjusting the shear edge member toward and away from the cutting path of the knife blade.

42. A slicing station for a food loaf slicing machine according to Claim 41 in which the shear edge adjustment means further includes a timing belt encompassing and engaging all of the adjustment shafts so that movement of one adjustment shaft moves all other adjustment shafts equally.

43. A slicing station for a food loaf slicing machine according to Claim 40 in which:

the shear edge member comprises an elongated block of a machinable resin having at least one opening for receiving one end of a food loaf on the food loaf path, and a plurality of resilient guides for guiding the food loaf into the opening in a direction parallel to the predetermined direction.

44. A shear edge member for a slicing station of a high speed food loaf slicing machine including food loaf support means defining a food loaf path, loaf feed means for feeding a food loaf along the food loaf path toward the slicing station, a shear edge member for guiding the food loaf from the food loaf path into the slicing station, the slicing station including a knife blade movable along a predetermined cutting path through a slicing range intersecting the end of a food loaf on the food loaf path and a cyclic drive for driving the knife blade cyclically along its cutting path a predetermined cycle rate, the slicing machine further comprising receiving means for collecting and removing groups of food loaf slices cut from the food loaf at the slicing station, the shear edge member comprising:

an elongated block of a machinable resin having at least one loaf-receiving opening for receiving one end of a food loaf on the food loaf path;

and a plurality of resilient guides for guiding the food loaf into the loaf-receiving opening.

45. A slicing station for a food loaf slicing machine according to Claim 44 in which the shear edge member has two loaf-receiving openings each shaped to correspond to a predetermined food loaf cross-section, and in which one of the resilient guides is positioned between and serves both loaf-receiving openings.

46. A slicing station for a food loaf slicing machine according to Claim 44 in which the loaf-receiving opening is of U-shaped configuration, so that a food loaf projecting into the opening is unrestrained by the shear edge member in one direction.

47. A slicing station for a high speed food loaf slicing machine including food loaf support means defining first and second parallel food loaf paths, loaf feed means for feeding a food loaf along each food loaf path toward a slicing station, and receiving means for collecting and removing groups of food loaf slices cut from the food loaves at the slicing station, the slicing station comprising:

a knife blade movable along a predetermined cutting path through a slicing range intersecting the ends of

food loaves on the food loaf paths;

a cyclic drive, connected to the knife blade, for driving the knife blade cyclically along its cutting path at a predetermined cycle rate,

first and second loaf doors, each mounted for pivotal movement between a blocking position blocking access of a food loaf to the knife blade on one food loaf path and an inactive position clear of that path;

and door actuation means to actuate each of the food loaf doors between its blocking and inactive positions.

48. A slicing station for a food loaf slicing machine according to Claim 47 and further comprising:

a marker, movable with the knife blade as the knife blade moves along its cutting path; and

a sensor, mounted in fixed position in the slicing station, for sensing the presence of the marker at a preselected location indicative of location of the knife blade at a predetermined home position on its cutting path,

the door actuation means actuating both of the food loaf doors to their blocking positions when the sensor determines that the knife blade is in its home position.

49. A slicing station for a food loaf slicing machine according to any of Claims 28 to 48 in which the marker is a permanent magnet and the sensor is responsive to magnetic flux.

50. An improved high speed food loaf slicing machine comprising a slicing station including a knife blade and a knife blade drive cyclically driving the knife blade along a predetermined cutting path, and loaf support means supporting a first food loaf and a second food loaf for movement along first and second loaf paths, respectively, into the slicing station for repetitive slicing of both loaves by the knife blade,

the improvement comprising:

a receiver, including a receiver conveyor having a plurality of spaced receiver conveyor belts, located below the slicing station to receive food loaf slices cut from the first and second food loaves, respectively, to form a first food loaf slice group and a second food loaf slice group;

a receiver lift mechanism connected to the receiver for moving the receiver vertically toward and away from the slicing station;

a receiver conveyor drive for driving the receiver conveyor horizontally at a predetermined discharge speed to discharge food loaf slice groups from the receiver;

a deceleration conveyor for receiving food loaf slice groups from the receiver; and

a deceleration conveyor drive for driving the deceleration conveyor at a predetermined speed lower than the discharge speed.

51. An improved high speed food loaf slicing machine according to Claim 50 in which:

the receiver includes a receiver grid comprising a plurality of grid members aligned with spaces between the receiver conveyor belts, the food slices cut from the first and second food loaves being received on the receiver grid; and in which

the receiver lift mechanism is connected to the receiver grid for moving the receiver grid vertically.

52. An improved high speed food loaf slicing machine according to Claim 51 in which the improvement further comprises a receiver weighing mechanism connected to the receiver grid for weighing the food loaf slices on the receiver grid.

53. An improved high speed food loaf slicing machine according to Claim 50 in which:

the food loaf slices cut by the knife blade are collected on the belts of the receiver conveyor and the receiver lift mechanism is connected to the receiver conveyor and moves the receiver conveyor vertically.

54. An improved high speed food loaf slicing machine according to Claim 50 in which the improvement further comprises:

a deceleration conveyor lift mechanism for adjusting the deceleration conveyor vertically to maintain the deceleration conveyor in alignment with the receiver conveyor to receive groups of food loaf slices from the receiver conveyor.

55. An improved high speed food loaf slicing machine according to Claim 50 in which the improvement further comprises:

a plurality of receiving pin wheels aligned with the spaces between the receiver conveyor belts;

and in which the receiver conveyor drive is connected to the receiving pin wheels and drives those pin wheels at a peripheral speed corresponding to the discharge speed when food loaf slice groups are discharged from the receiver.

56. An improved high speed food loaf slicing machine according to Claim 50 in which the improvement further comprises:

a scale conveyor, including a plurality of spaced scale conveyor belts, movable between a normal elevated

position, aligned with the deceleration conveyor to receive food loaf slice groups therefrom, and a depressed weighing position;

a scale conveyor drive driving the scale conveyor belts horizontally;

a scale conveyor lift mechanism for moving the scale conveyor between its normal elevated and depressed weighing positions; and

a first weighing grid, including a plurality of first grid members aligned with spaces between the scale conveyor belts, the top of the first weighing grid being below the scale conveyor belts when the scale conveyor is in its normal elevated position and above the scale conveyor belts when the scale conveyor is in its depressed weighing position.

57. An improved high speed food loaf slicing machine according to Claim 56 in which the deceleration conveyor drive and the scale conveyor drive are a single drive mechanism driving both the deceleration conveyor and the scale conveyor horizontally at the same speed.

58. An improved high speed food loaf slicing machine according to Claim 56 in which the improvement further comprises:

a second weighing grid, including a plurality of second grid members, the top of the second weighing grid being aligned with the top of the first weighing grid and the second grid members being aligned with spaces between the scale conveyor belts different from the inter-belt spaces in the scale conveyor with which the first grid members are aligned, so that when the scale conveyor is in its depressed weighing position a group of slices from the first food loaf is deposited on the first weighing grid and a group of slices from the second food loaf is deposited on the second weighing grid;

a first weighing mechanism connected to the first weighing grid to generate a first weight signal representative of the weight of a first group of food loaf slices; and

a second weighing mechanism connected to the second weighing grid to generate a second weight signal representative of the weight of a second group of food loaf slices.

59. An improved high speed food loaf slicing machine according to Claim 58 in which the receiver conveyor, the deceleration conveyor, and the scale conveyor are each wide enough to transport first and second food loaf slice groups in side-by-side alignment, and in which the first and second weighing grids are positioned in alignment with opposite sides of the scale conveyor to weight first and second groups of food loaf slices, respectively, the improvement further comprising:

a first transfer conveyor, aligned with one side of the scale conveyor, for receiving first food loaf slice groups from the scale conveyor; and

a second transfer conveyor, aligned with the other side of the scale conveyor in side-by-side relation to the first transfer conveyor, for receiving second food loaf slice groups from the scale conveyor.

60. An improved high speed food loaf slicing machine according to Claim 59 in which the improvement further comprises:

a first transfer conveyor lift mechanism, responsive to the first weight signal, connected to the first transfer conveyor for moving the first transfer conveyor vertically between an accept position and a reject position;

a second transfer conveyor lift mechanism, responsive to the second weight signal, connected to the second transfer conveyor for moving the second transfer conveyor between an accept position and a reject position;

61. An improved high speed food loaf slicing machine including a slicing station in which a knife blade is driven cyclically along a predetermined cutting path and food loaf feed means for feeding a food loaf into the slicing station for repetitive slicing of the food loaf,

the improvement comprising:

a receiver conveyor, including a plurality of horizontally spaced receiver conveyor belts, located below the slicing station to receive food loaf slices as cut in a food loaf slice group;

a plurality of receiving pin wheels each aligned with the space between two adjacent receiver conveyor belts;

a receiver conveyor drive for driving the receiver conveyor horizontally at a given speed and for driving the receiving pin wheels at a peripheral speed equal to the given speed; and

a receiver lift mechanism connected to the receiver conveyor for moving the receiver conveyor vertically toward and away from the slicing station.

62. An improved high speed food loaf slicing machine according to Claim 61 in which the improvement further comprises:

a deceleration conveyor for receiving groups of food loaf slices from the receiving conveyor; and

a deceleration conveyor lift mechanism for adjusting one end of the deceleration conveyor vertically into alignment with the receiver conveyor.

63. An improved high speed food loaf slicing machine according to Claim 62 in which the improvement further comprises:
a scale conveyor, including a plurality of horizontally spaced scale conveyor belts, for receiving groups of food loaf slices from the other end of the deceleration conveyor;
a scale conveyor lift mechanism for moving the scale conveyor vertically between a normal elevated position and a depressed weighing position;
a weighing grid including a plurality of grid members aligned with spaces between the scale conveyor belts, the top of the weighing grid being below the scale conveyor belts when the scale conveyor is in its normal elevated position and above the scale conveyor belts when the scale conveyor is in its depressed weighing position; and
a conveyor drive connected to the deceleration conveyor and to the scale conveyor to drive both at the same speed.

64. An improved high speed food loaf slicing machine according to Claim 61 in which the improvement further comprises:
a scale conveyor, including a plurality of horizontally spaced scale conveyor belts, for receiving groups of food loaf slices from the receiver conveyor;
a scale conveyor lift mechanism for moving the scale conveyor vertically between a normal elevated position and a depressed weighing position; and
a weighing grid including a plurality of grid members aligned with spaces between the scale conveyor belts, the top of the weighing grid being below the scale conveyor belts when the scale conveyor is in its normal elevated position and above the scale conveyor belts when the scale conveyor is in its depressed weighing position.

65. An improved high speed food loaf slicing machine according to Claim 64 in which the improvement further comprises:
a transfer conveyor, having one end aligned with the scale conveyor, receiving groups of food loaf slices from the scale conveyor; and
a transfer conveyor lift mechanism connected to the transfer conveyor for moving the other end of the transfer conveyor vertically between an accept position and a reject position.

66. An improved high speed food loaf slicing machine according to Claim 65 in which the improvement further comprises:
a conveyor drive connected to the deceleration conveyor, the scale conveyor, and the transfer conveyor to drive all of those conveyors at the same speed.

67. A method of manufacturing a series of groups of food loaf slices comprising the following steps:

A. driving a food loaf at a constant speed in a loaf feed direction toward engagement with a continuously cyclically driven knife blade for X knife blade cycles so that the knife blade cuts a slice from the food loaf in each knife blade cycle;

B. collecting successive food loaf slices cut in step A on a receiver to form a group of X food loaf slices on the receiver;

C. driving the food loaf away from the knife blade at a given speed for a given time interval Y;

D. again driving the food loaf toward the knife blade at the given speed for a second time interval Y to counteract step C;

E. during steps C and D, discharging the group of food loaf slices from the receiver;

F. after step E, weighing the group of food loaf slices to generate a weight signal representative of the weight of the food loaf slice group;

G. depositing the group of food loaf slices on a transfer conveyor;

H. deflecting the transfer conveyor between a reject position and an accept position in response to the weight signal of step F;

and repeating steps A through H in manufacturing a series of food loaf slice groups each including X slices.

68. A method of manufacturing a series of groups of food loaf slices, according to Claim 67, in which the receiver of step B is a receiver conveyor, and comprising the following sub-steps:
B1. during step B, lowering the receiving conveyor by a distance equal to the thickness of a slice X times

while a group of X food loaf slices is deposited on the receiving conveyor; and

E1. during step E, discharging the food loaf slice group from the receiving conveyor by driving the receiving conveyor rapidly, in a predetermined forward direction, away from the knife blade.

69. A method of manufacturing a series of groups of food loaf slices, according to Claim 68, and comprising the following additional sub-step:

B2. during step B, driving the receiving conveyor slowly in the forward direction away from the knife blade to shingle the group of food loaf slices collected on the receiving conveyor.

70. A method of manufacturing a series of groups of food loaf slices, according to Claim 68, and comprising the following additional sub-step:

B3. during step B, driving the receiving conveyor slowly in a direction opposite to the forward direction to stack the group of food loaf slices collected on the receiving conveyor.

71. A method of manufacturing a series of groups of food loaf slices, according to Claim 67, in which the weighing of step F is carried out by means of a weighing grid positioned below but interleaved with the belts of a scale conveyor that is continuously driven in a forward direction away from the knife blade, the manufacturing method including the following sub-steps:

F1. lowering the scale conveyor once during each step F to a weighing position below the weighing grid, depositing any group of food loaf slices present on the scale conveyor onto the weighing grid; and

F2. after step F1, raising the scale conveyor back to its original level above the weighing grid to lift the food loaf slice group from the weighing grid.

72. A method of manufacturing a series of groups of food loaf slices, according to Claim 71, and comprising the following additional sub-steps:

F3. weighing the empty weighing grid at a time when the scale conveyor is at its original level above the weighing grid to generate a tare weight signal; and

F4. subtracting the tare weight signal of sub-step F3 from the weight signal of step F to generate a transfer conveyor weight control signal relating to the net weight of a stack of food loaf slices.

73. A method of manufacturing a series of groups of food loaf slices, according to Claim 72 in which step F3 occurs before step F1 in each manufacturing cycle.

74. A method of manufacturing a series of groups of food loaf slices, according to Claim 72, in which step H utilizes the transfer conveyor weight control signal of sub-step F4.

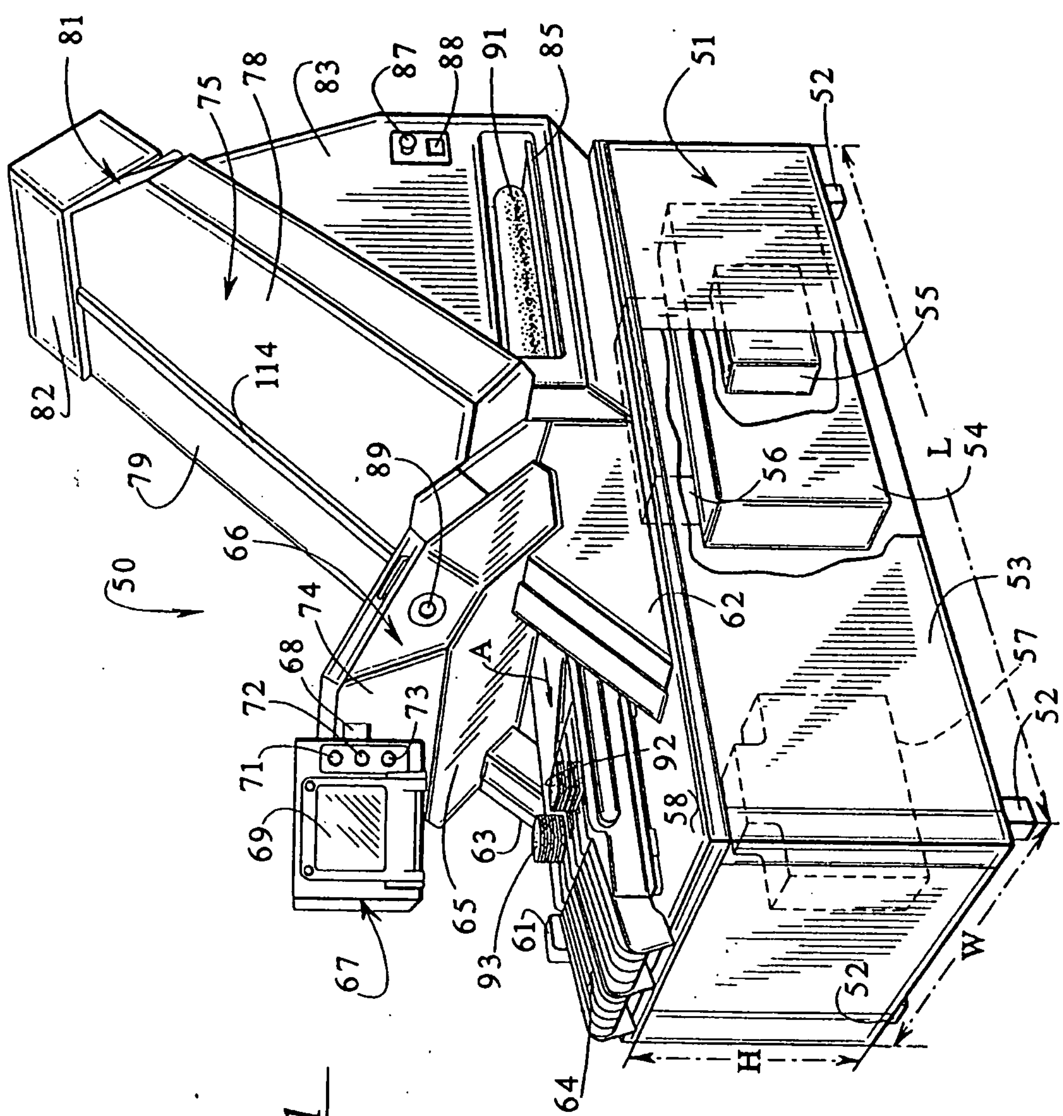
75. A method of manufacturing a series of groups of food loaf slices, according to Claim 67, and comprising the following additional sub-steps:

C1. interrupting driving of the food loaf for a given time interval at the end of the time interval Y of step C; and

C2. maintaining the interruption of sub-step C1 for a predetermined time interval 2Y.

76. A method of manufacturing a series of groups of food loaf slices, according to Claim 75, in which the sum of the time intervals 4Y, is an integral number of knife blade cycles.

77. A method of manufacturing a series of groups of food loaf slices, according to Claim 67 or 76, in which the given speed of steps C and D is the same as the constant food loaf driving speed of step A.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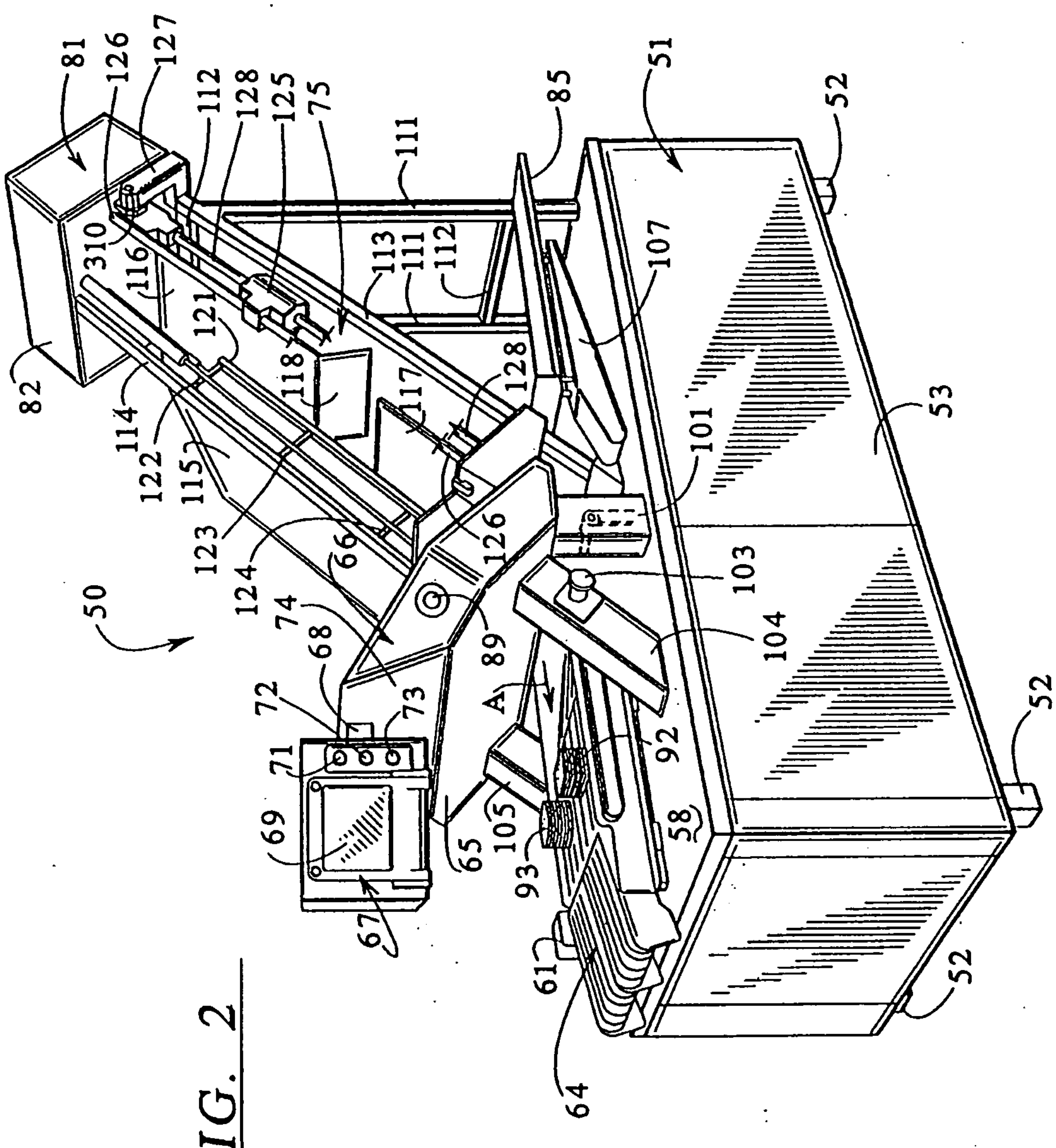
87
88
89
91
92
93
114
A
L
W
H

FIG. 1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127
128
310
A

FIG. 2

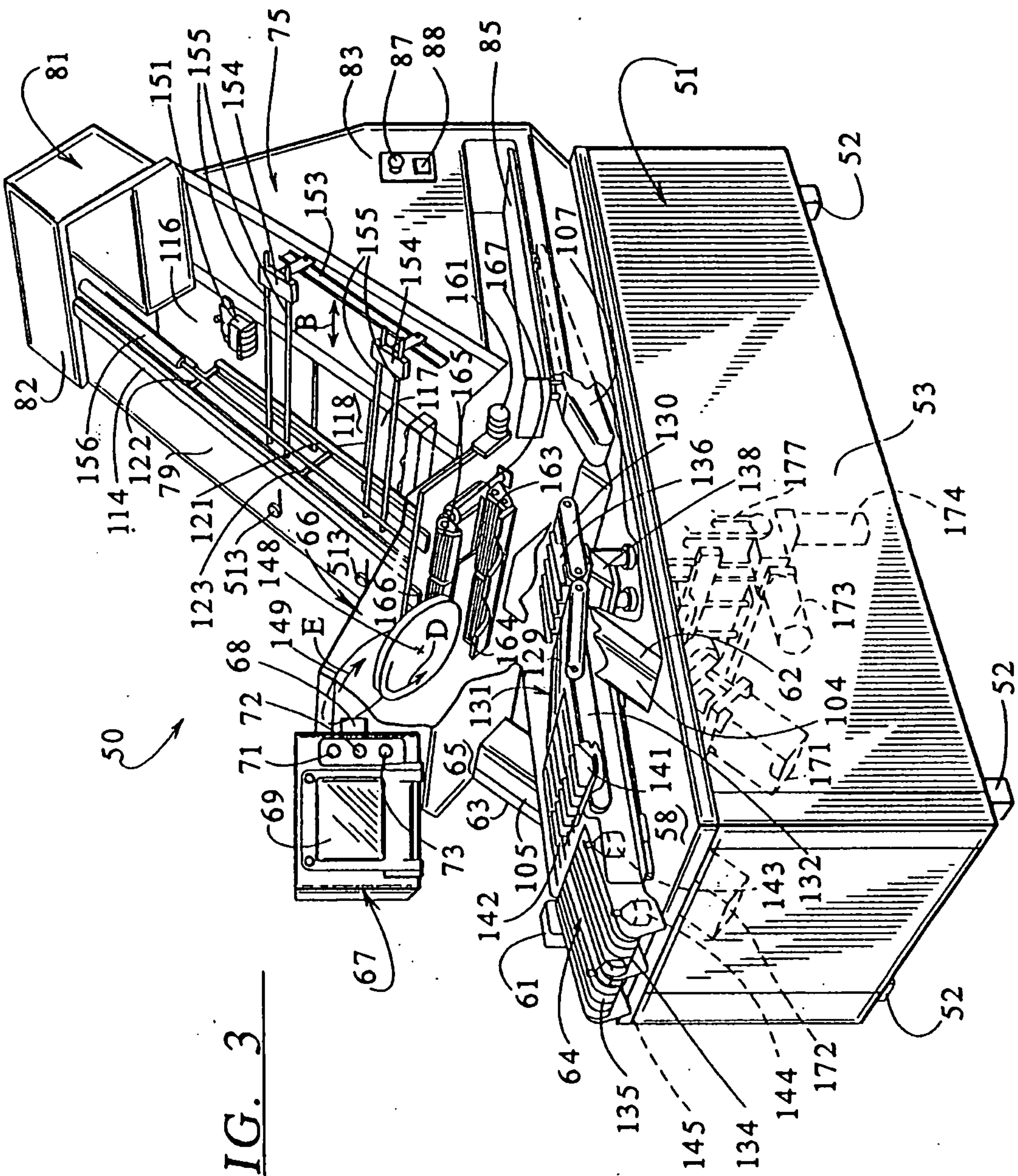


FIG. 3

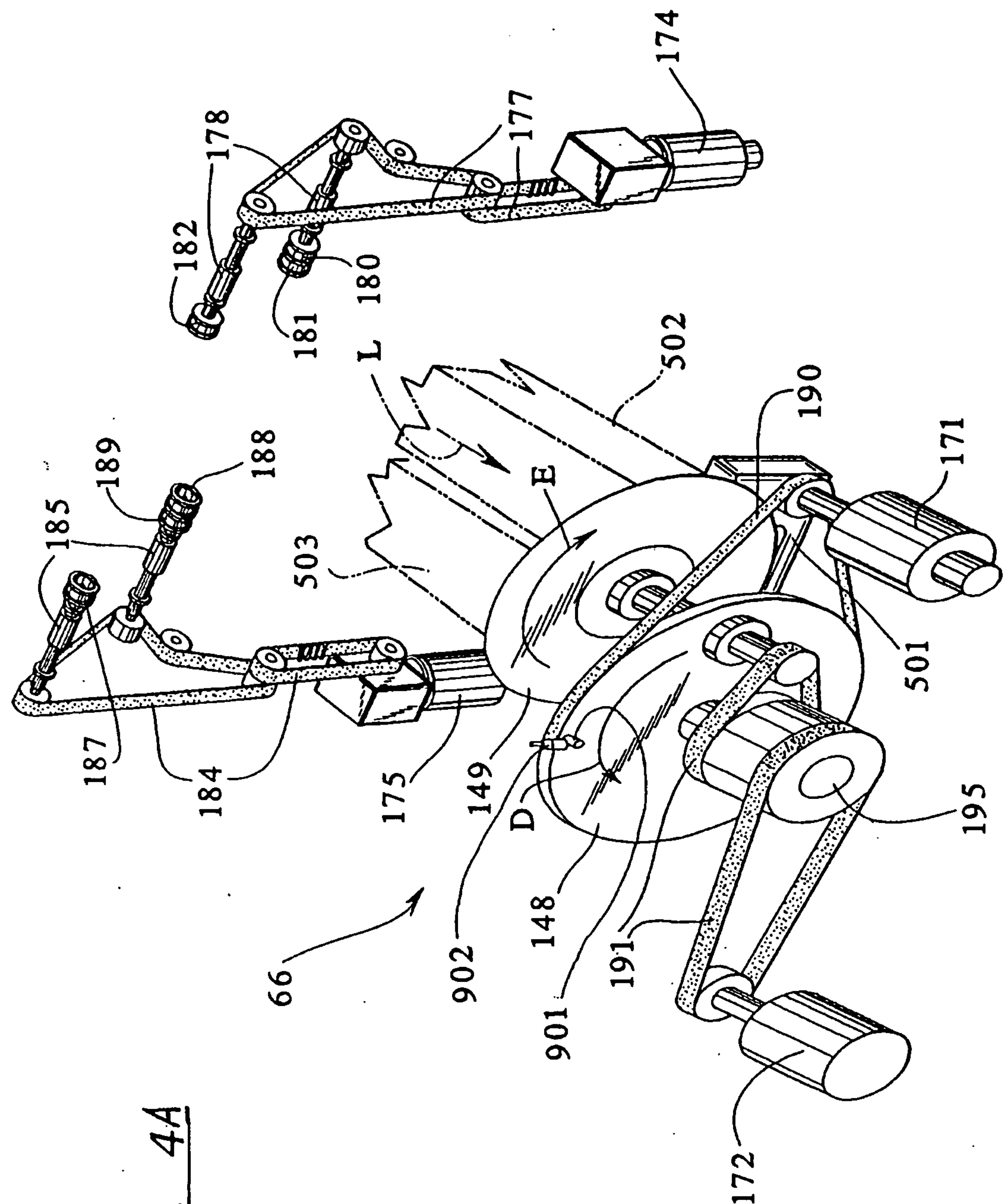

174
177
178
182
180
181
L
502
190
171
188
189
185
E
503
501
187
184
175
149
D
195
66
902
148
901
191
172

FIG. 4A

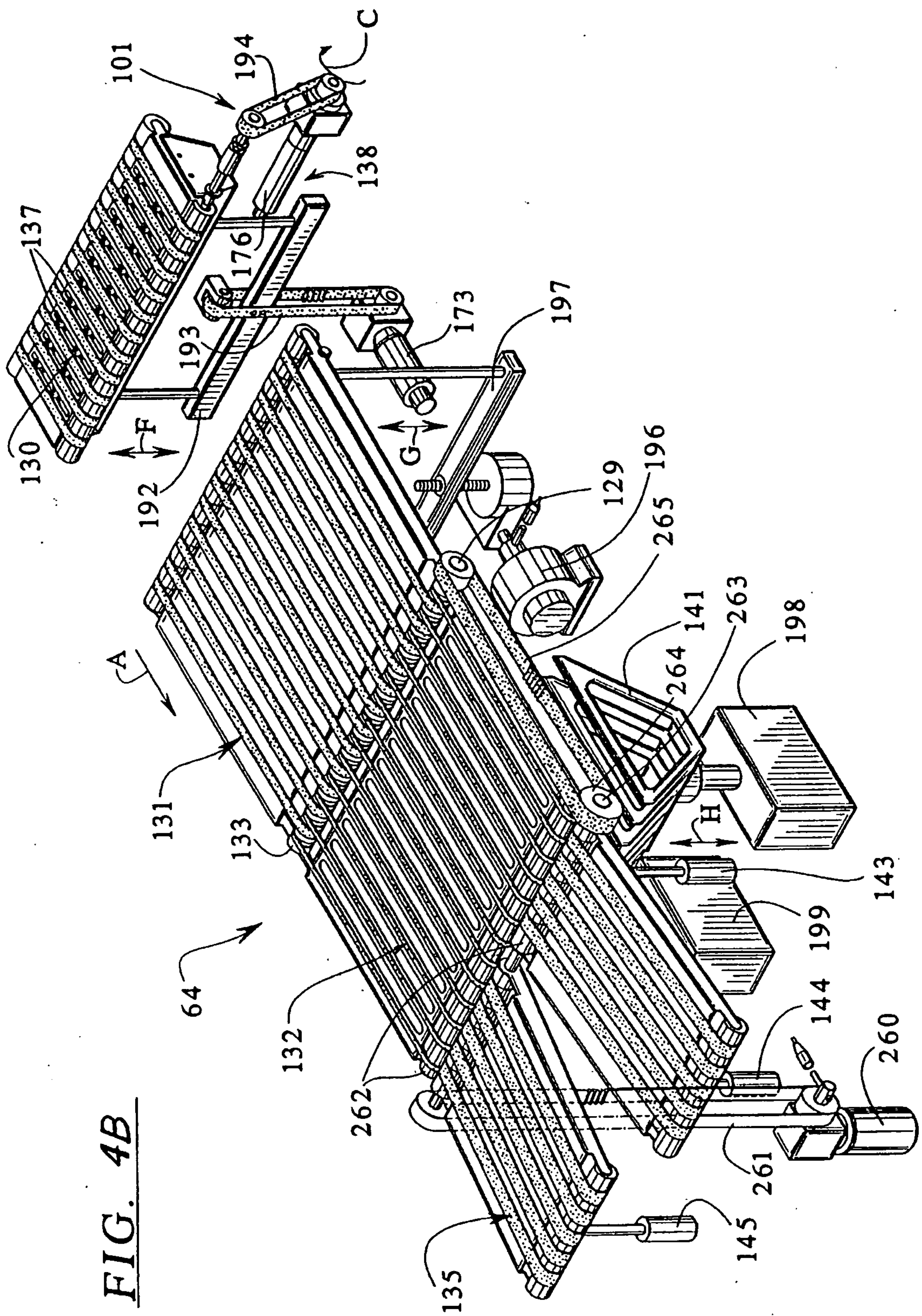
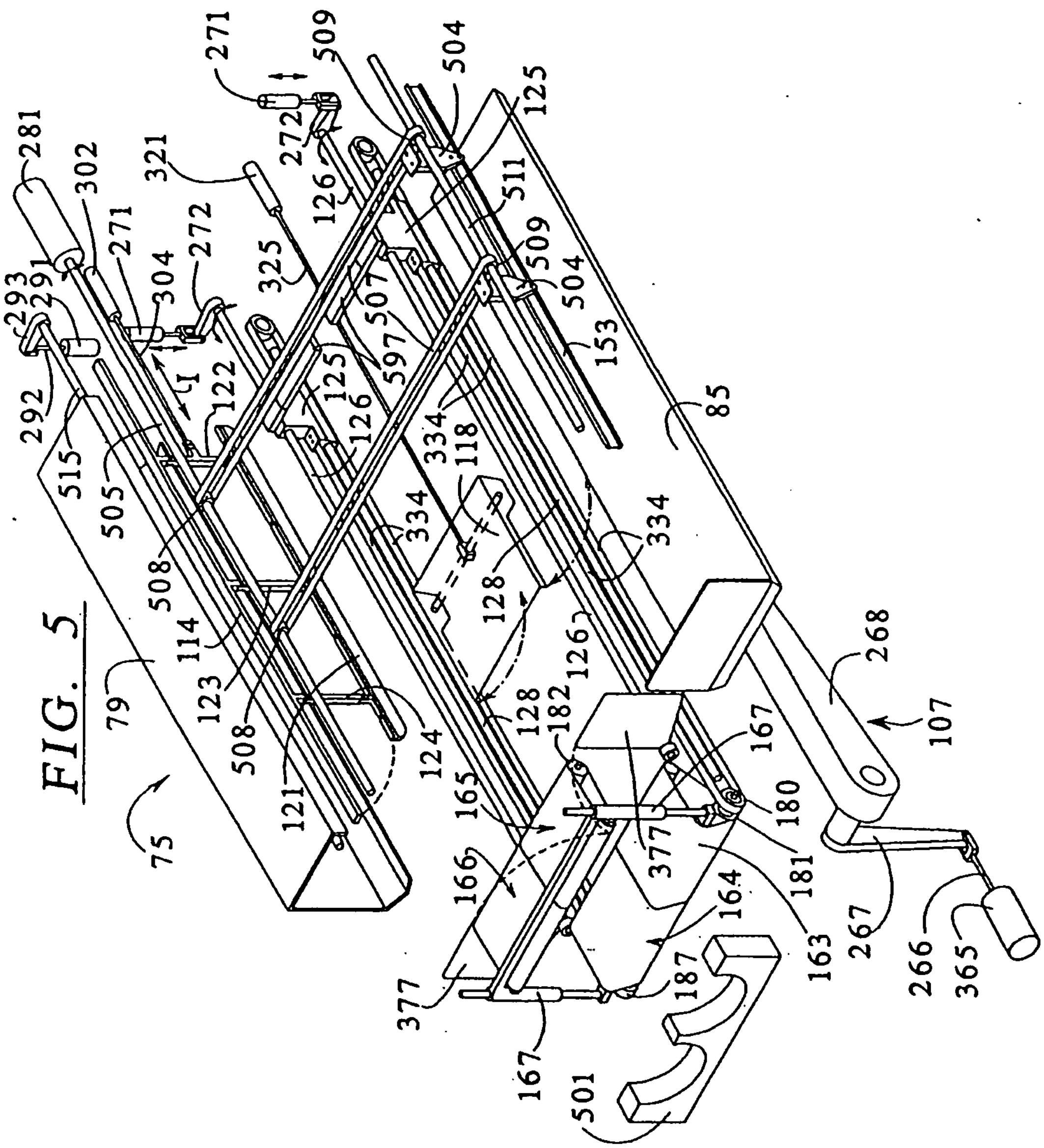

101
194
C
138
137
176
173
197
130
F
193
192
G
196
129
265
A
141
263
198
264
131
133
H
143
199
64
144
132
260
262
261
145
135

FIG. 4B



75
79
281
302
293
291
292
271
304
272
321
325
271
272
509
504
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126
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509
504
507
597
153
85
515
505
508
122
125
126
334
118
334
334
114
123
508
121
124
128
126
128
182
165
166
377
167
180
181
164
163
377
187
167
501
268
107
267
266
365

FIG. 5

FIG. 6A

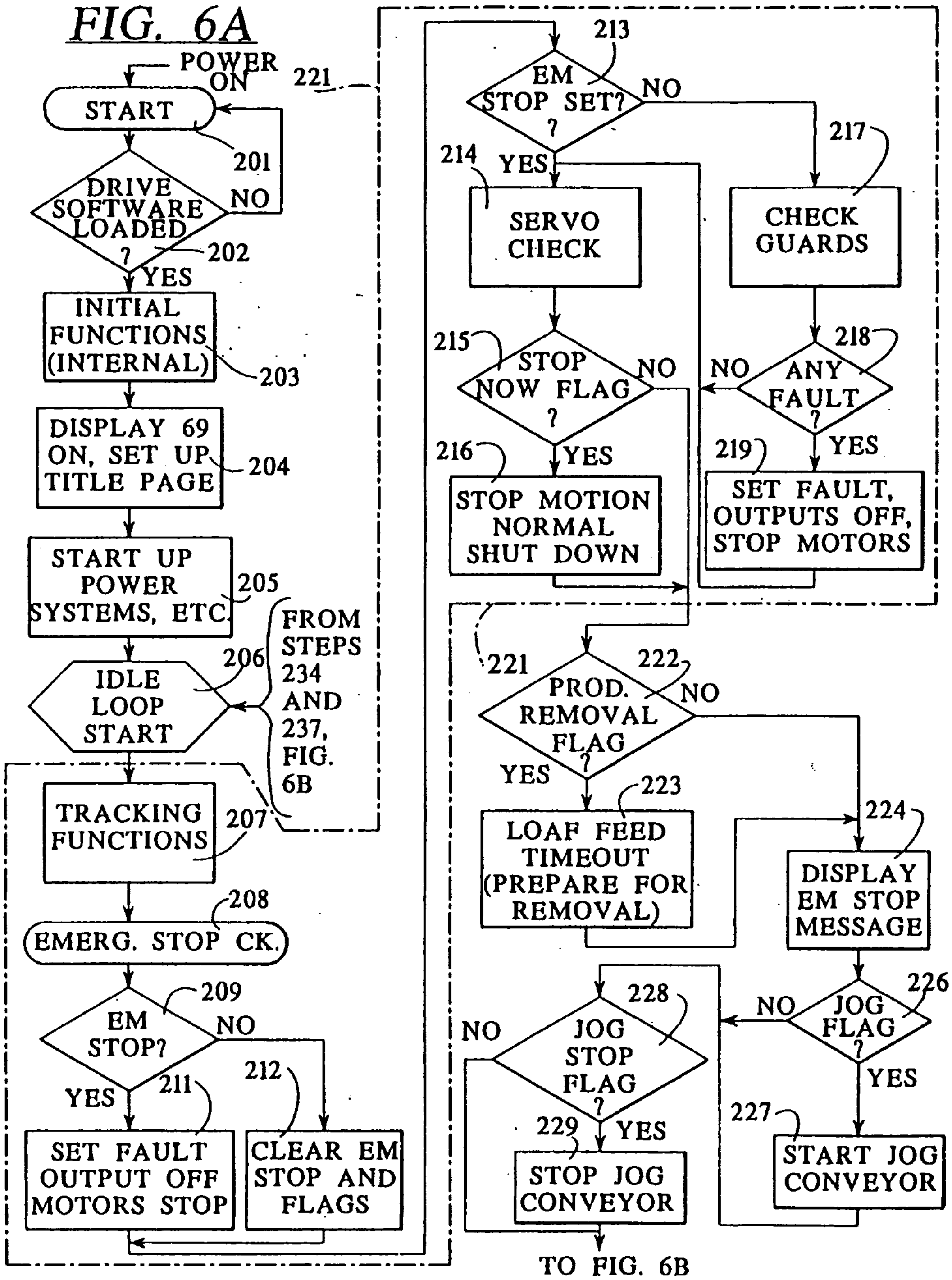
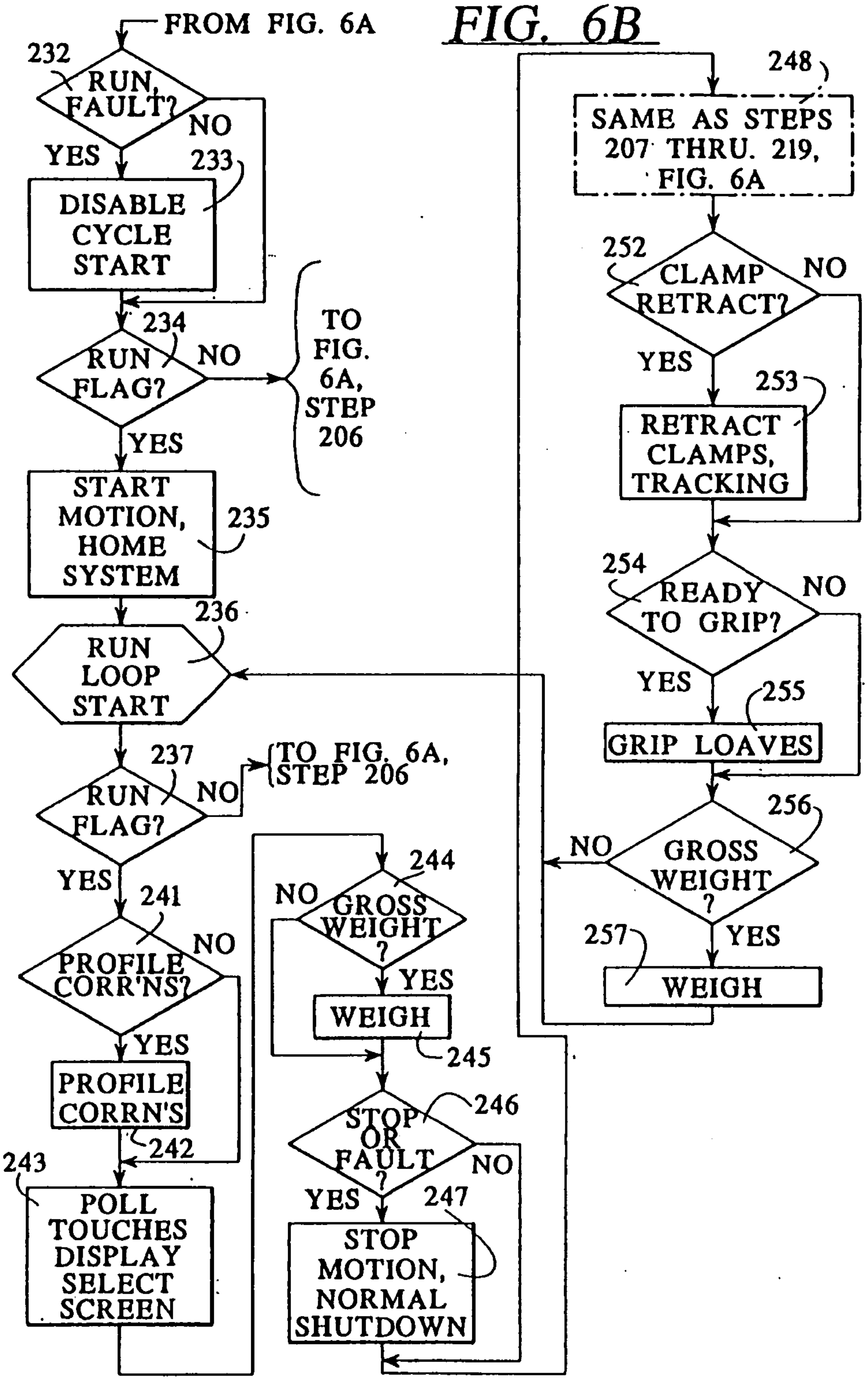

POWER ON
START
201
DRIVE SOFTWARE LOADED ?
NO
202
YES
INITIAL FUNCTIONS (INTERNAL)
203
DISPLAY 69 ON, SET UP TITLE PAGE
204
START UP POWER SYSTEMS, ETC.
205
IDLE LOOP START
206
FROM STEPS 234 AND 237, FIG. 6B
TRACKING FUNCTIONS
207
EMERG. STOP CK.
208
EM STOP?
209
NO
YES
211
212
SET FAULT OUTPUT OFF MOTORS STOP
CLEAR EM STOP AND FLAGS
221
EM STOP SET? ?
213
NO
214
YES
SERVO CHECK
217
CHECK GUARDS
215
STOP NOW FLAG ?
NO
YES
216
STOP MOTION NORMAL SHUT DOWN
218
NO
ANY FAULT ?
YES
219
SET FAULT, OUTPUTS OFF, STOP MOTORS
221
222
PROD. REMOVAL FLAG ?
NO
YES
223
LOAF FEED TIMEOUT (PREPARE FOR REMOVAL)
224
DISPLAY EM STOP MESSAGE
226
JOG FLAG ?
NO
YES
227
START JOG CONVEYOR
228
JOG STOP FLAG ?
NO
229
YES
STOP JOG CONVEYOR
TO FIG. 6B

FIG. 6B


FROM FIG. 6A
232
RUN, FAULT?
NO
YES
233
DISABLE CYCLE START
234
RUN FLAG?
NO
TO FIG. 6A, STEP 206
YES
START MOTION, HOME SYSTEM
235
236
RUN LOOP START
237
RUN FLAG?
NO
TO FIG. 6A, STEP 206
YES
241
PROFILE CORR'NS?
NO
YES
PROFILE CORRN'S
242
243
POLL TOUCHES DISPLAY SELECT SCREEN
244
GROSS WEIGHT ?
NO
YES
WEIGH
245
246
STOP OR FAULT ?
NO
YES
247
STOP MOTION, NORMAL SHUTDOWN
248
SAME AS STEPS 207 THRU. 219, FIG. 6A
252
CLAMP RETRACT?
NO
YES
253
RETRACT CLAMPS, TRACKING
254
READY TO GRIP?
NO
YES
255
GRIP LOAVES
256
GROSS WEIGHT ?
NO
YES
257
WEIGH

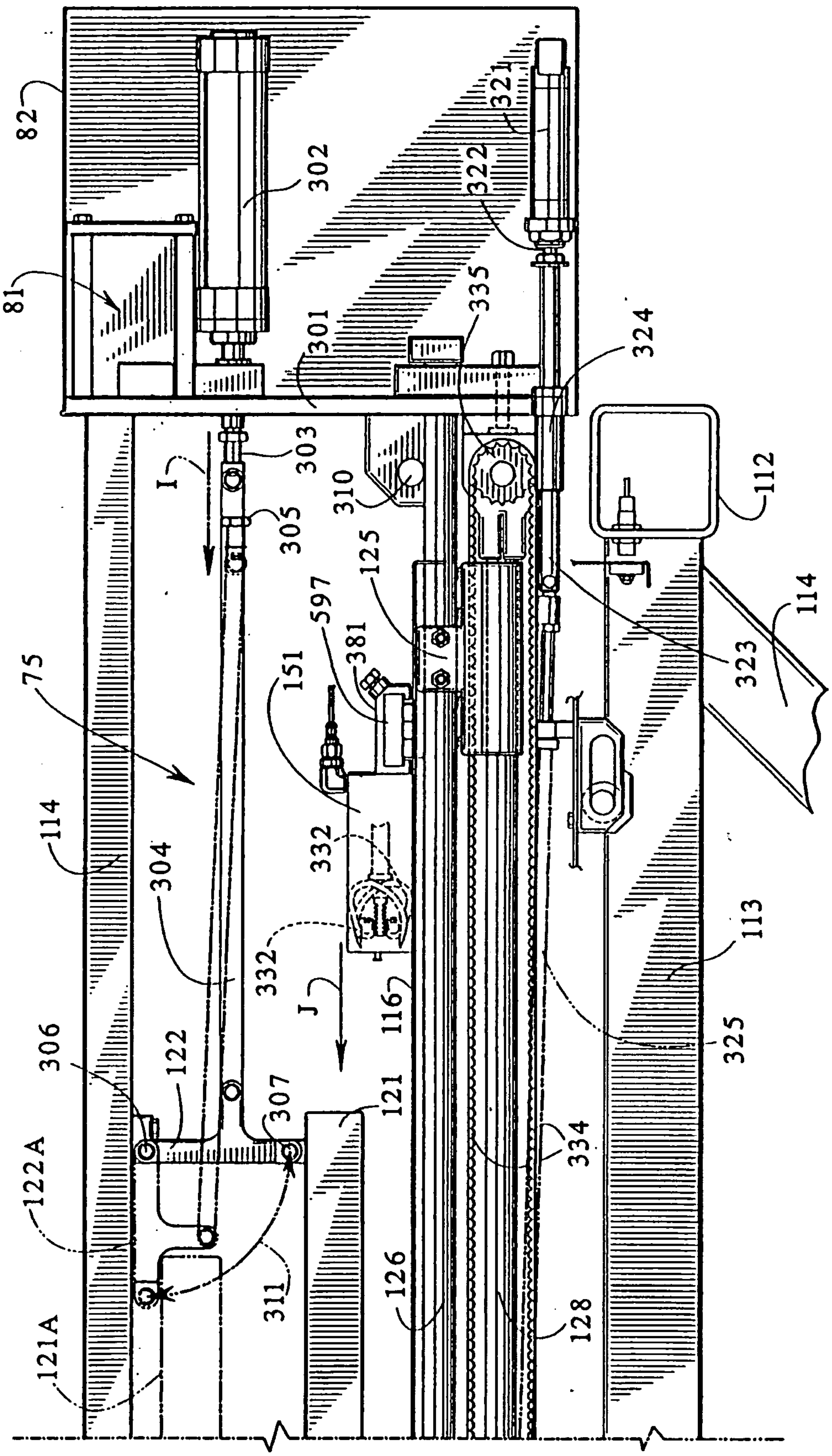

82
81
302
321
322
335
324
301
303
310
305
125
112
114
323
597
381
151
75
114
304
332
332
116
J
I
113
325
306
122
122A
307
121
334
311
126
128
121A

FIG. 7A

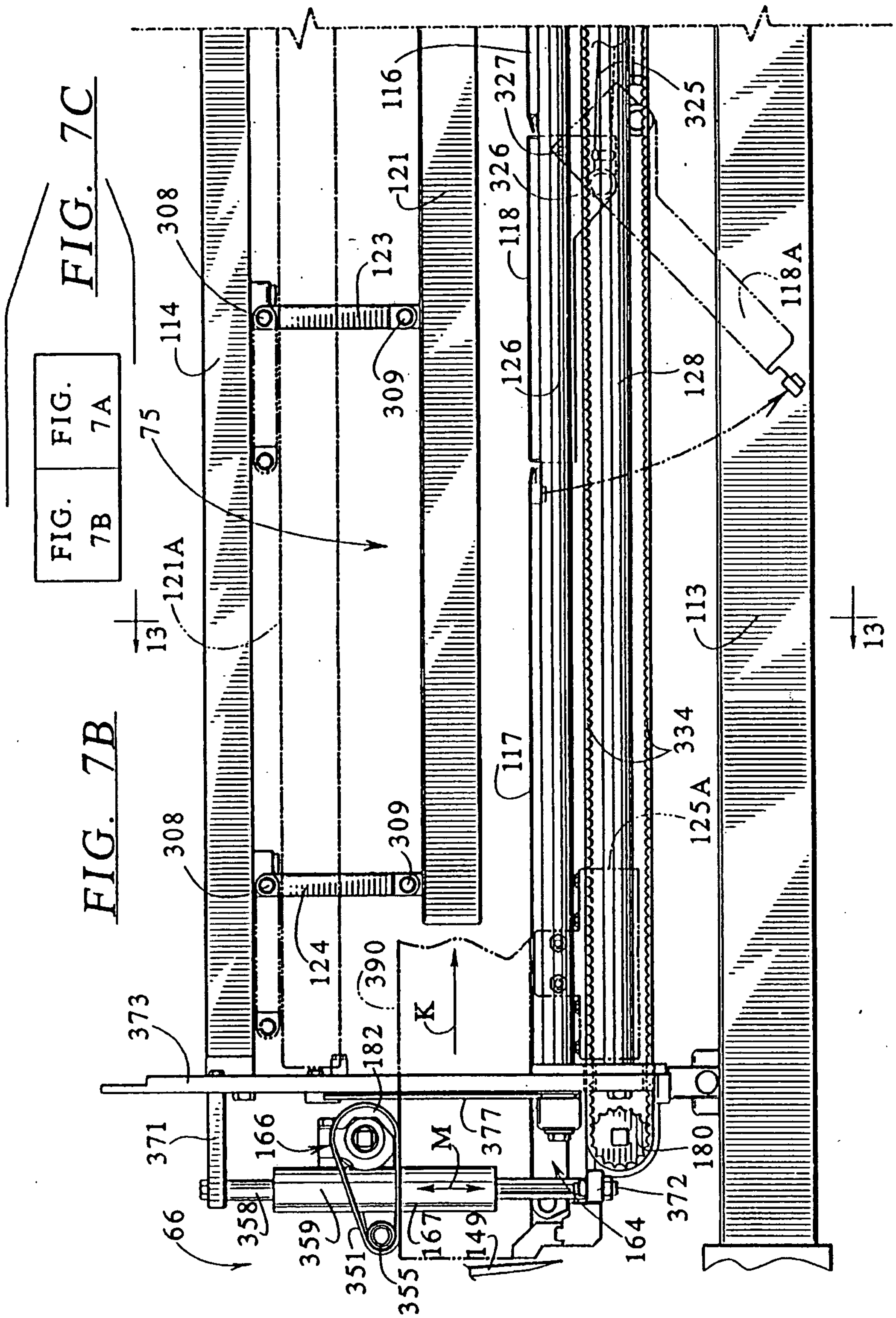


FIG. 7B

FIG. 7C

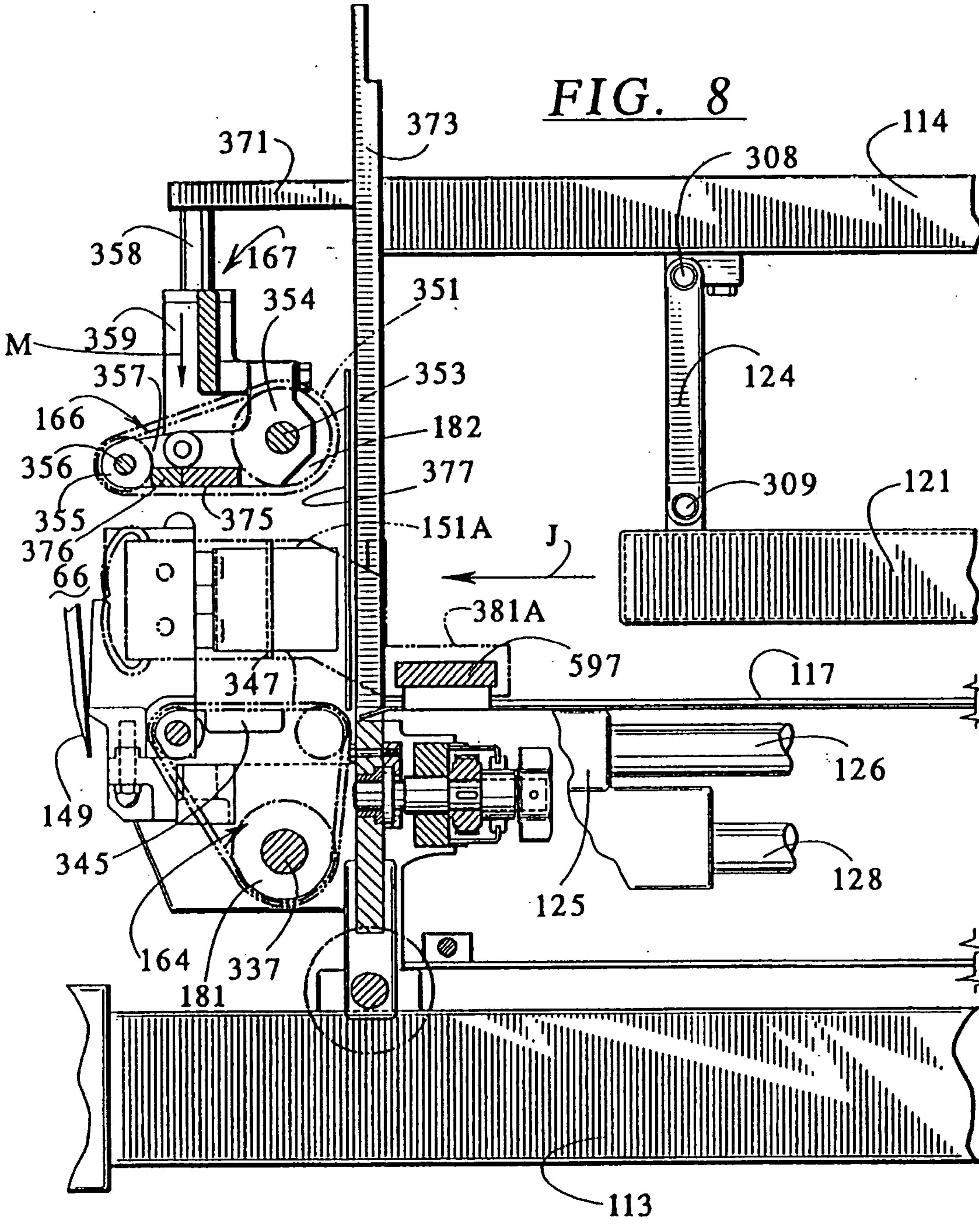
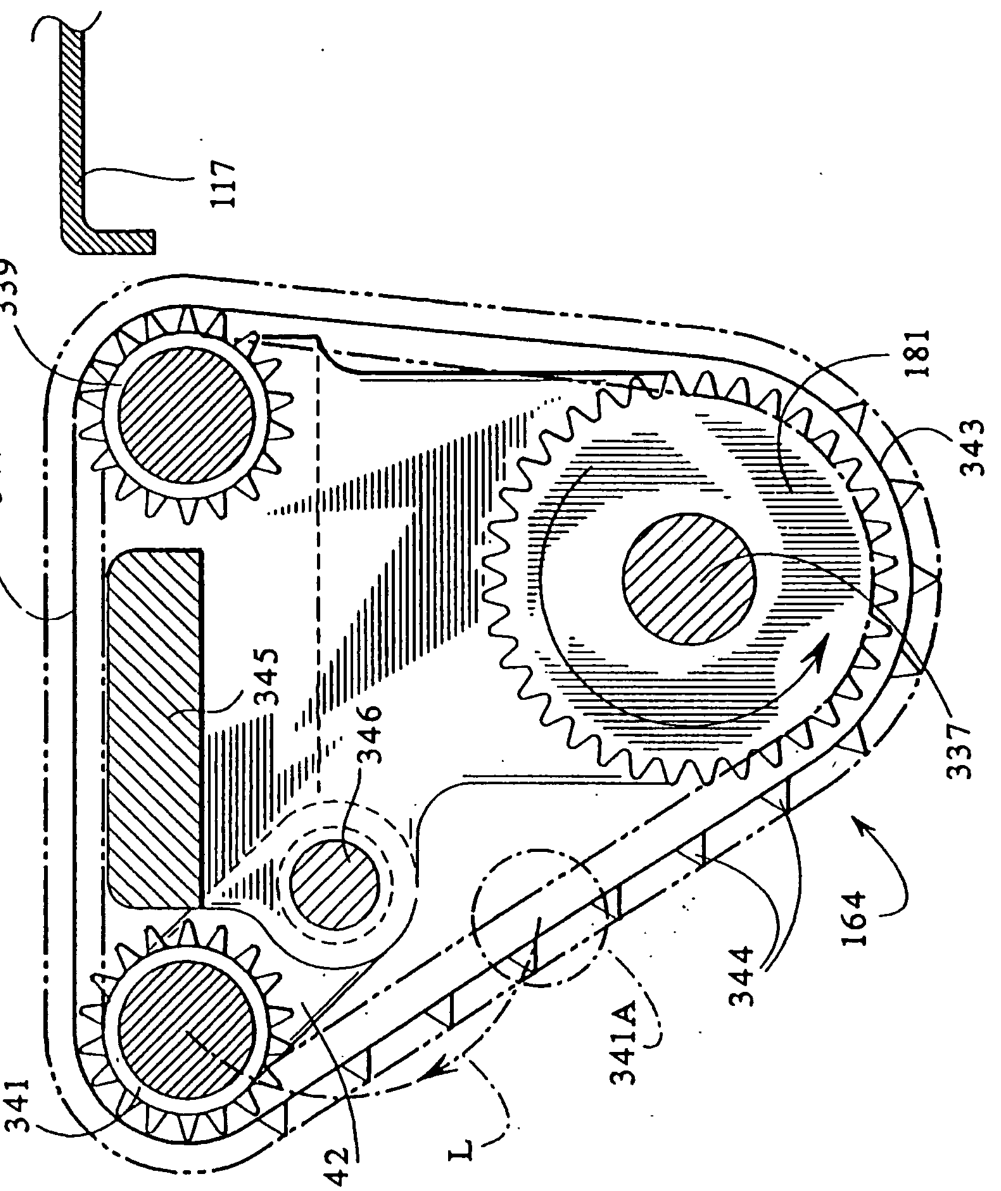


FIG. 8
373
371
114
308
358
167
351
354
M
359
353
357
124
166
182
356
377
309
121
355
375
376
151A
J
66
381A
597
347
117
126
149
345
125
128
164
337
181
113

FIG. 9



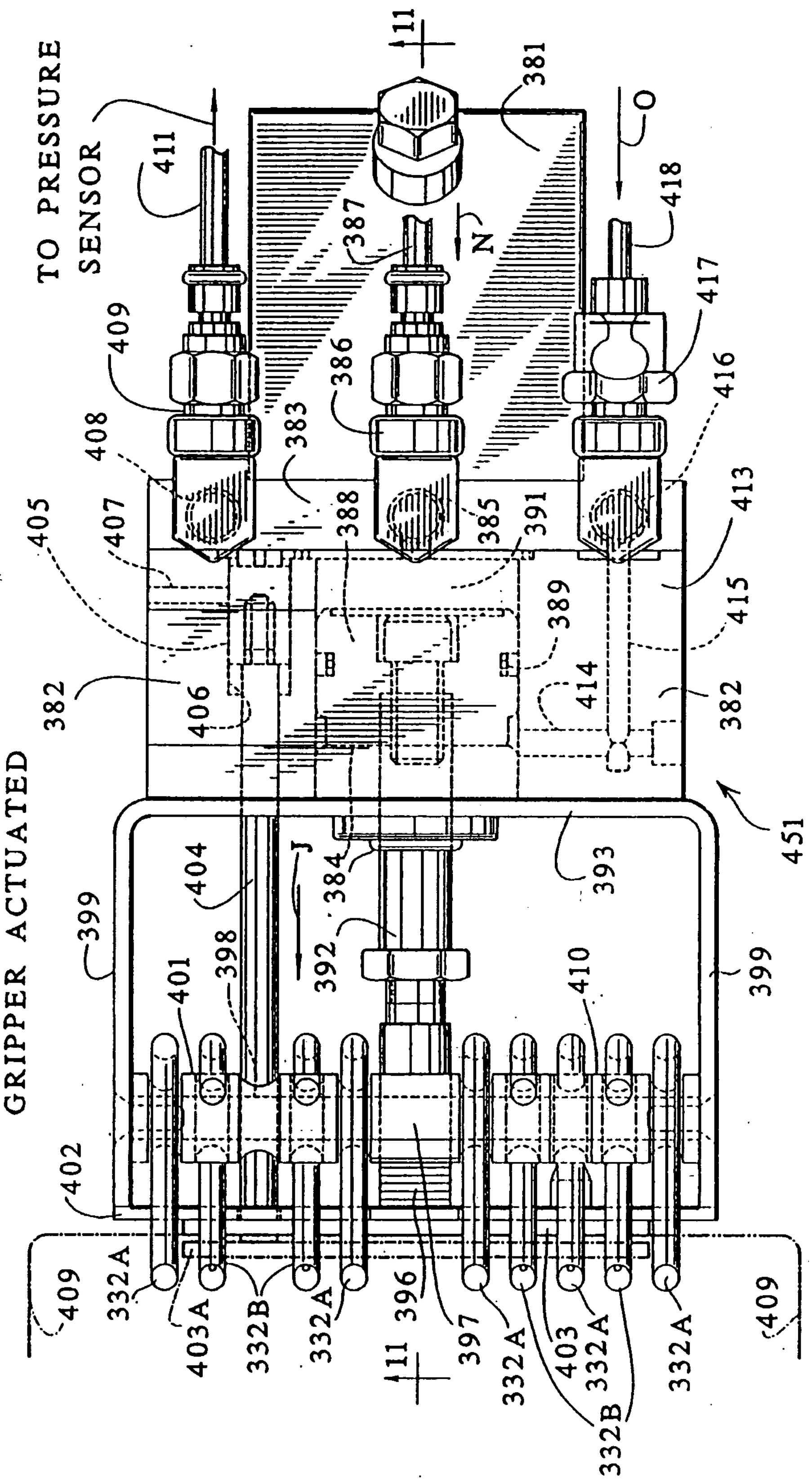


FIG. 10
GRIPPER ACTUATED

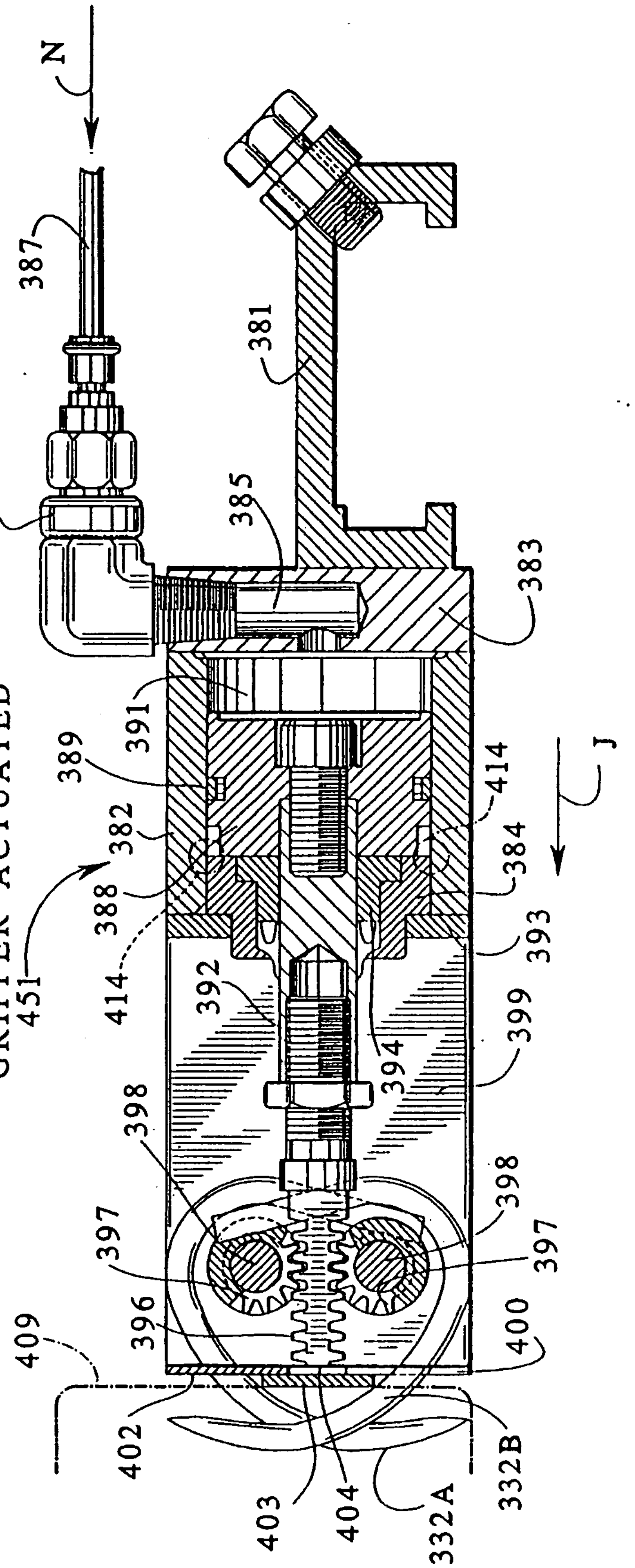


FIG. 11
GRIPPER ACTUATED

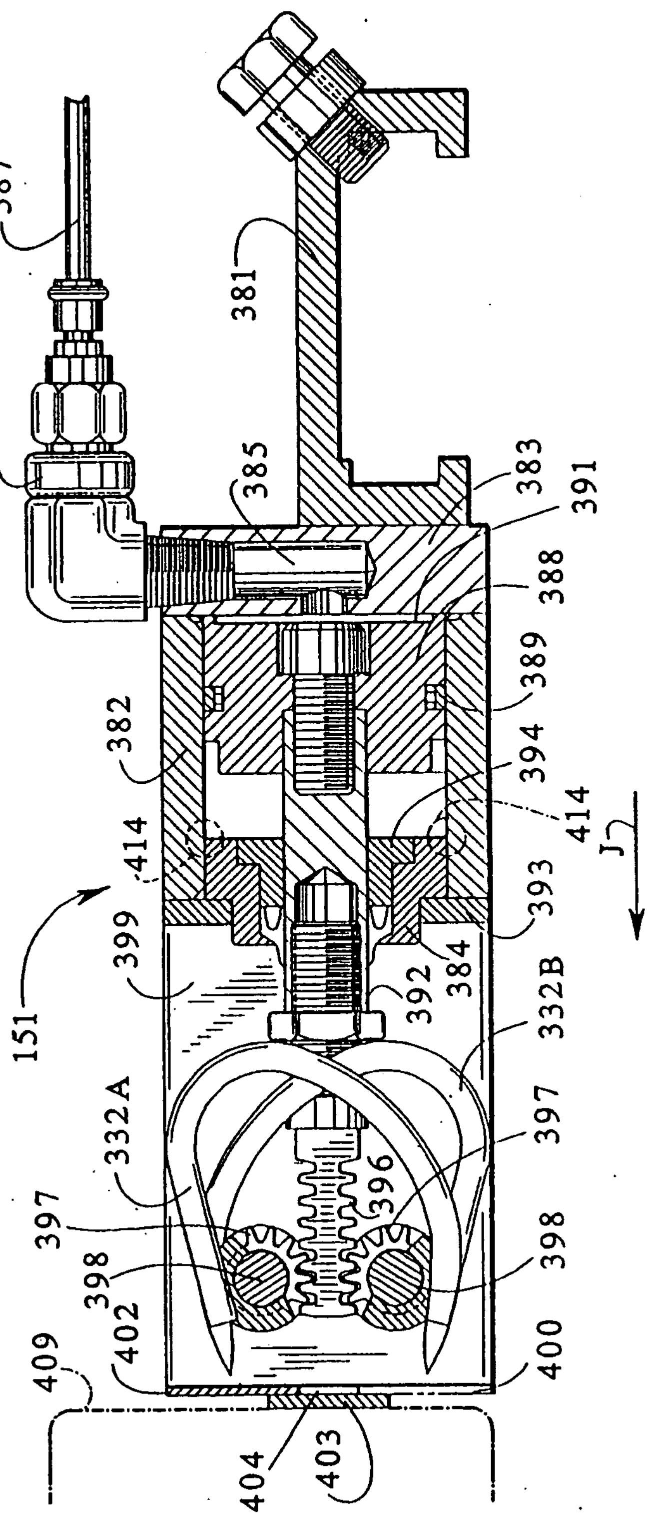
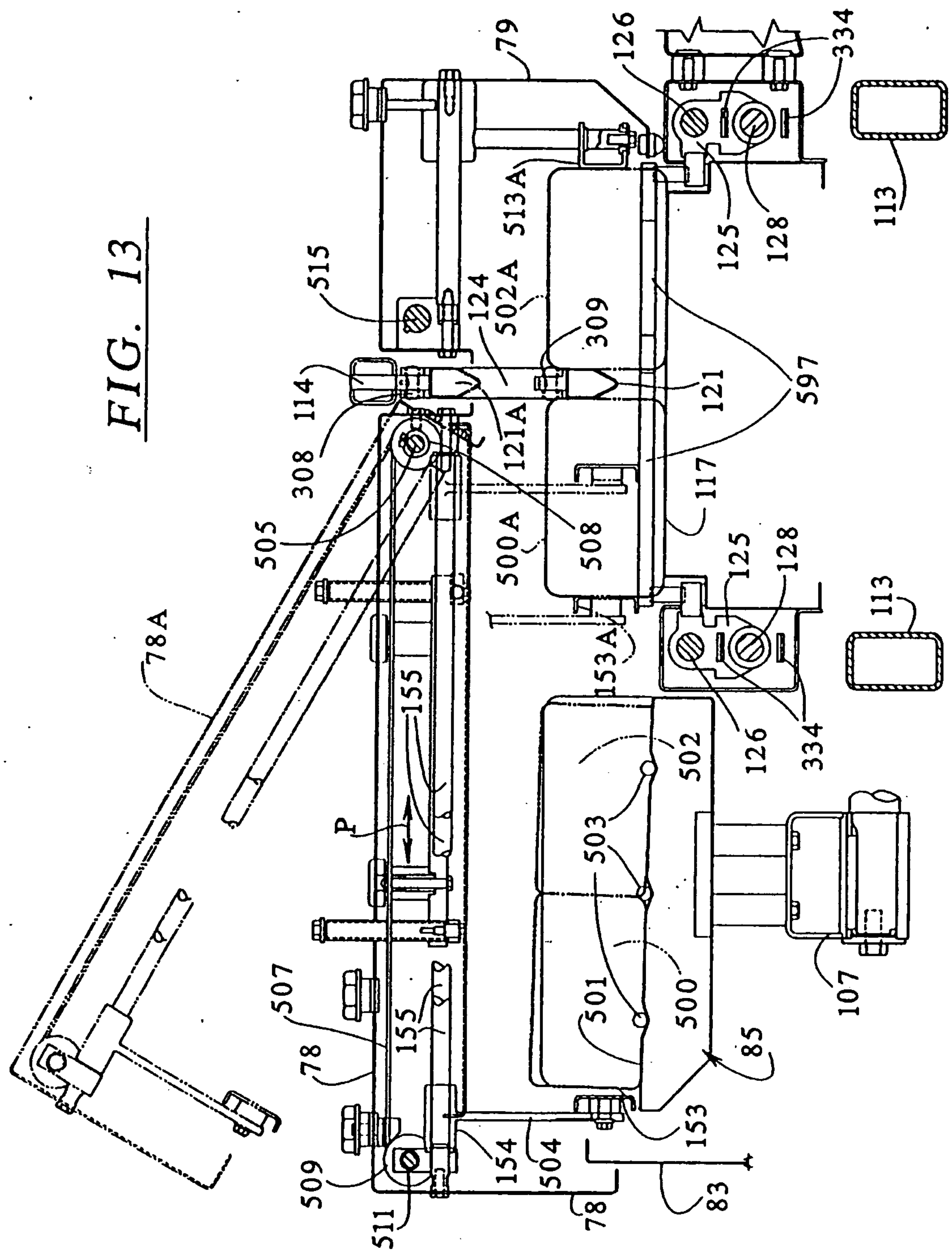


FIG. 12
GRIPPER NOT ACTUATED

FIG. 13


78A
505
308
114
515
124
502A
513A
79
126
334
309
121
121A
597
125
128
113
117
508
500A
153A
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154
504
78
153
83

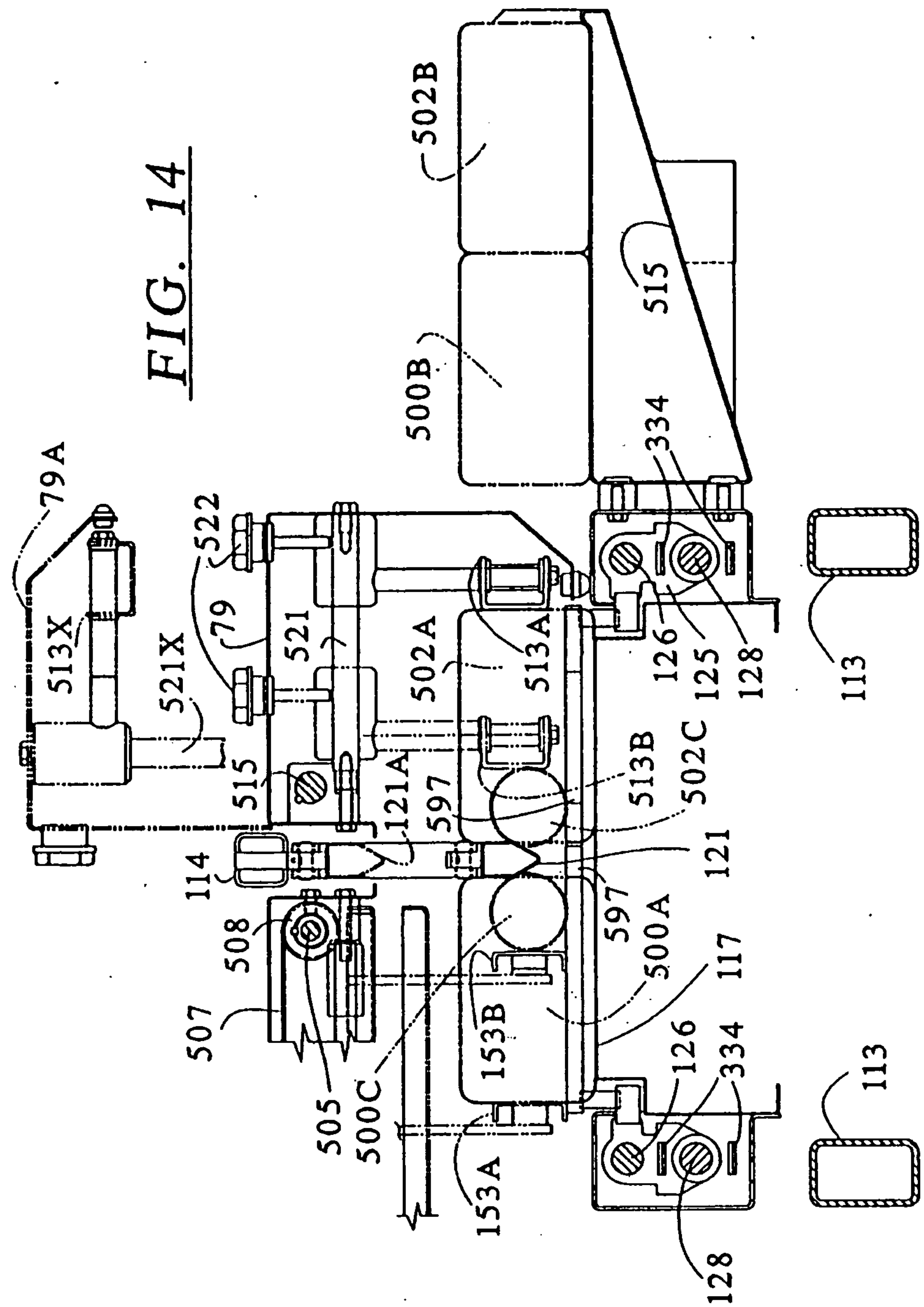

79A
513X
79
521X
522
521
515
121A
114
508
507
505
500C
153A
153B
500A
597
121
513B
502C
513A
502A
500B
502B
515
334
126
125
128
113
117
126
334
128
113

FIG. 14

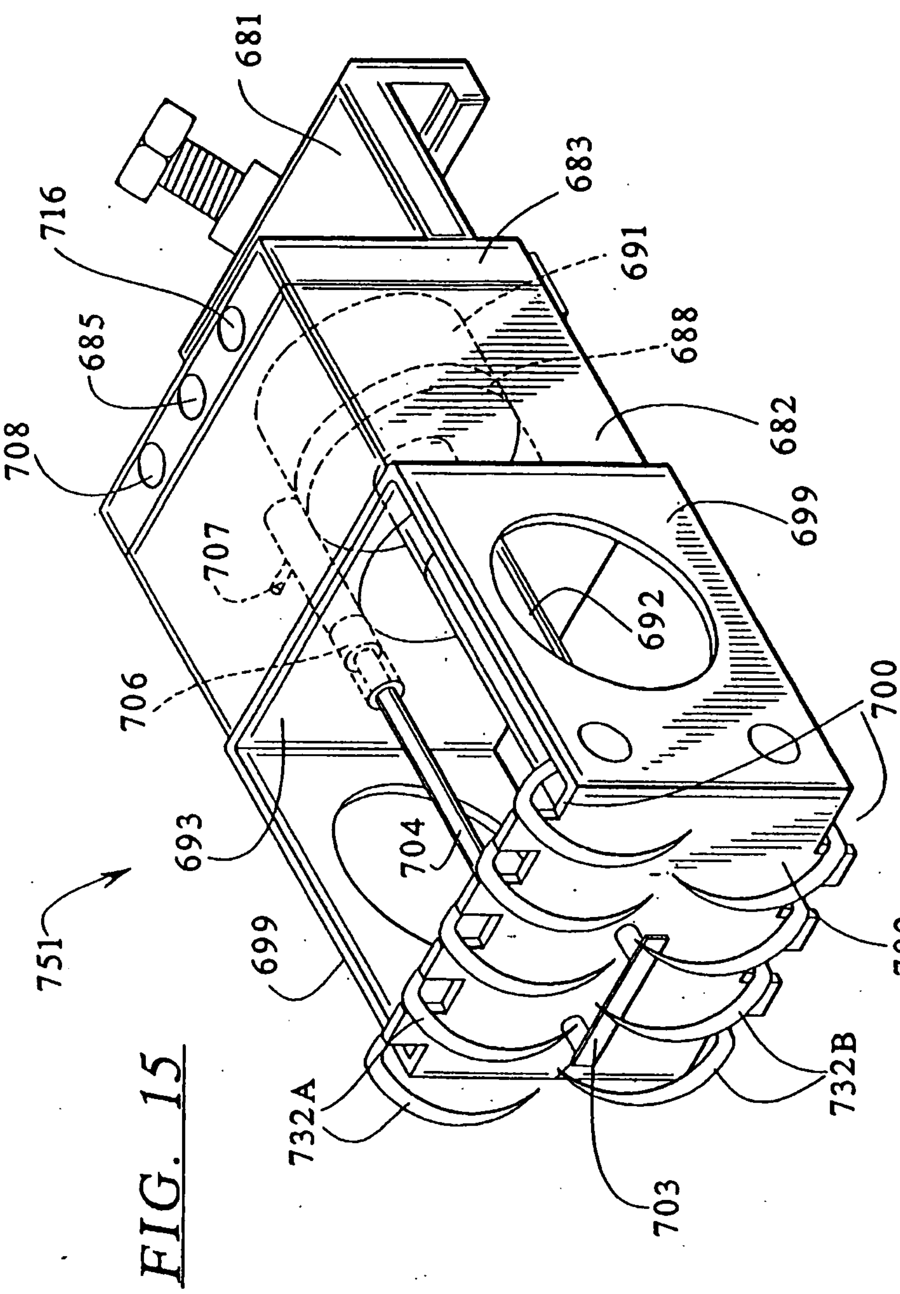
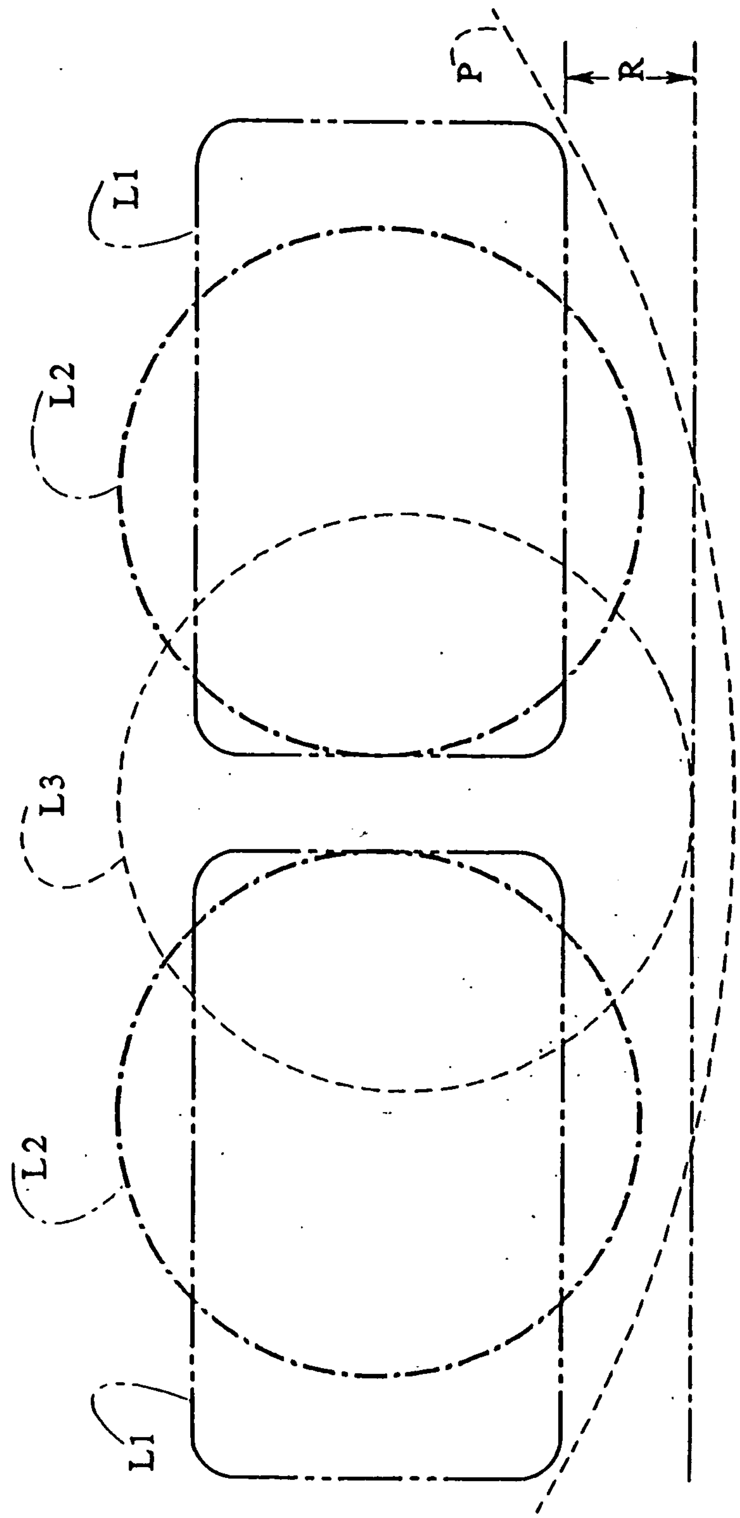

681
683
716
691
685
688
708
682
707
699
692
706
700
693
704
751
699
702
732A
732B
703

FIG. 15

FIG. 16



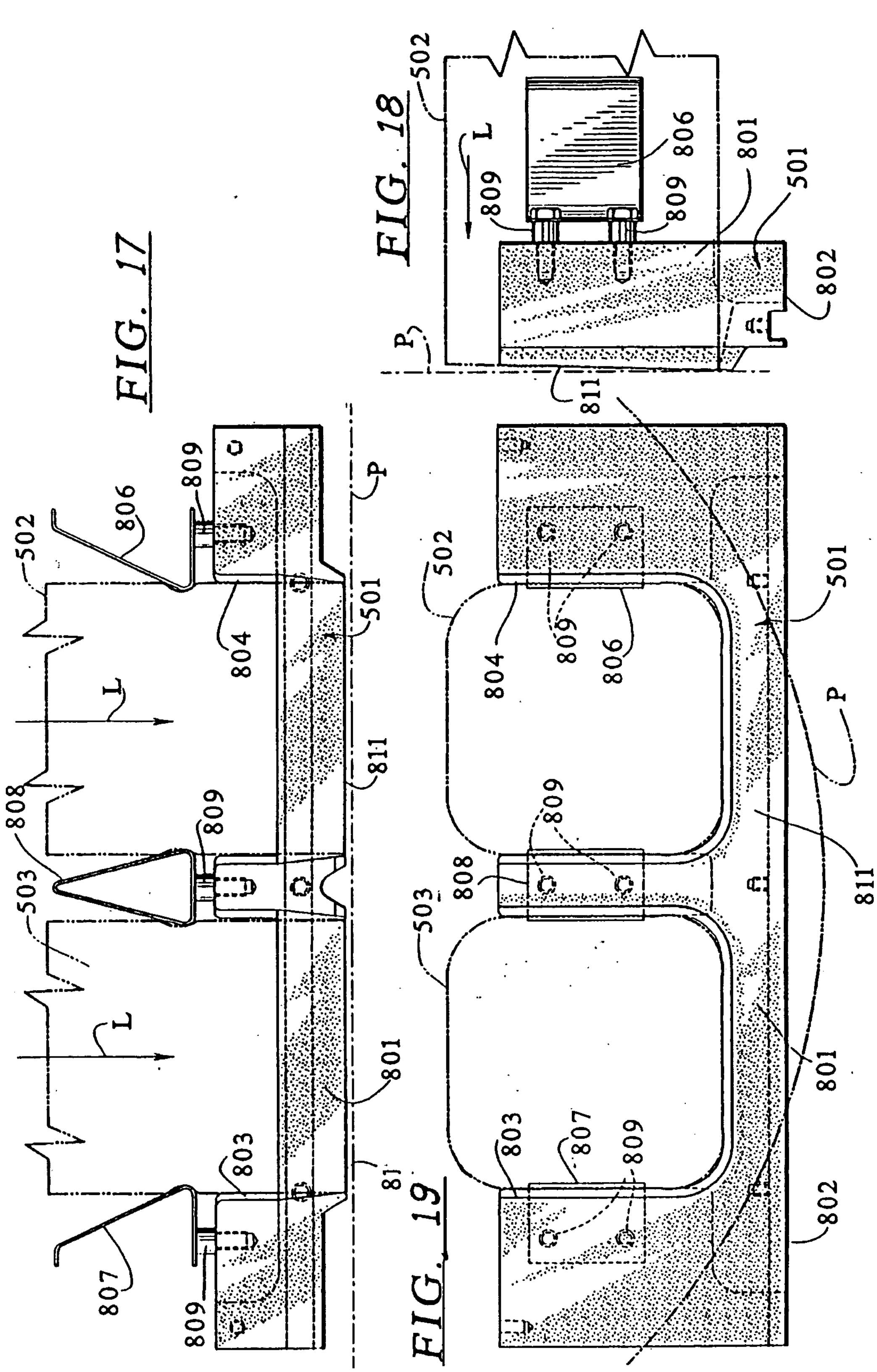


FIG. 17

FIG. 18

FIG. 19

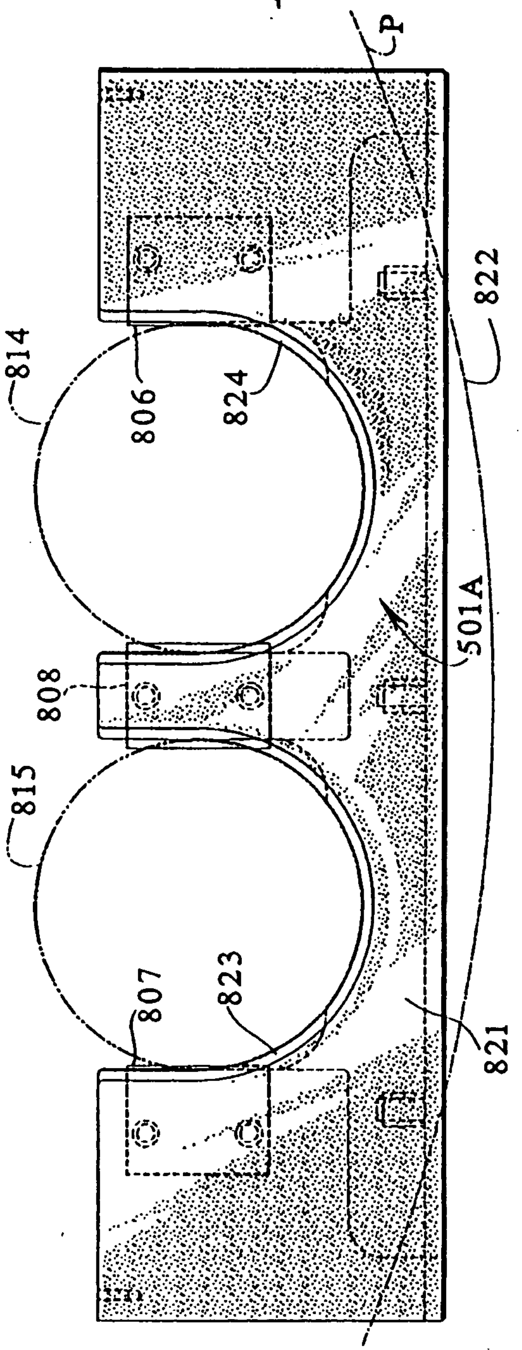

P
822
814
806
824
501A
808
815
807
823
821

FIG. 20

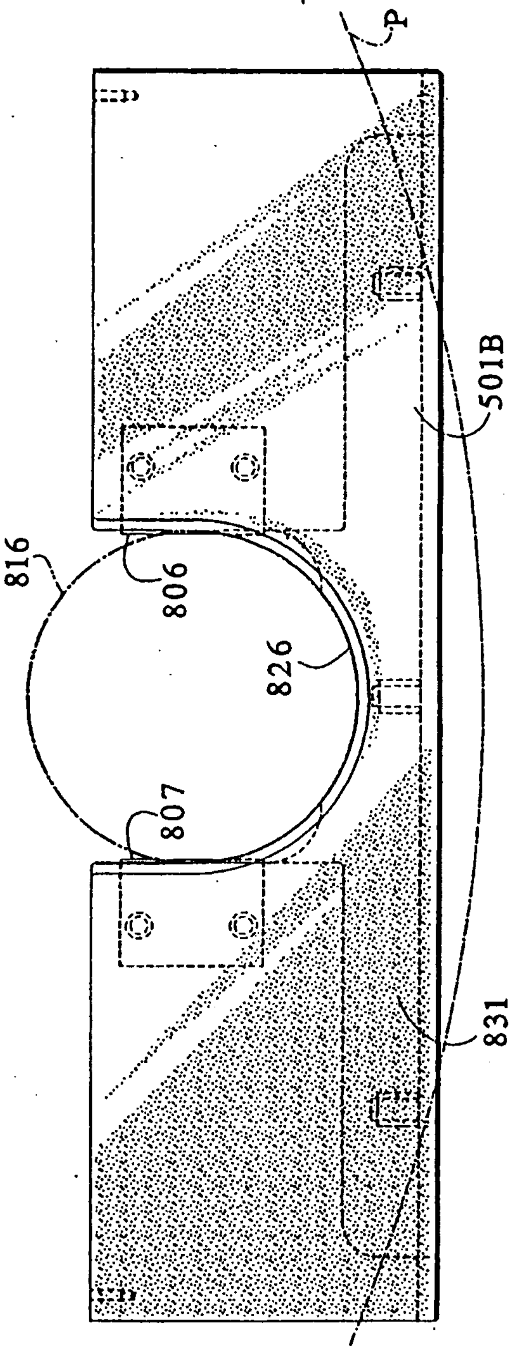

P
501B
816
806
826
807
831

FIG. 21

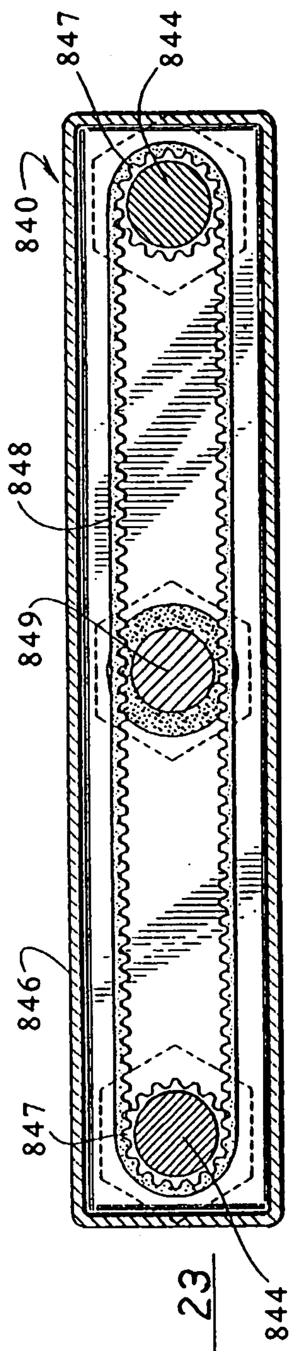
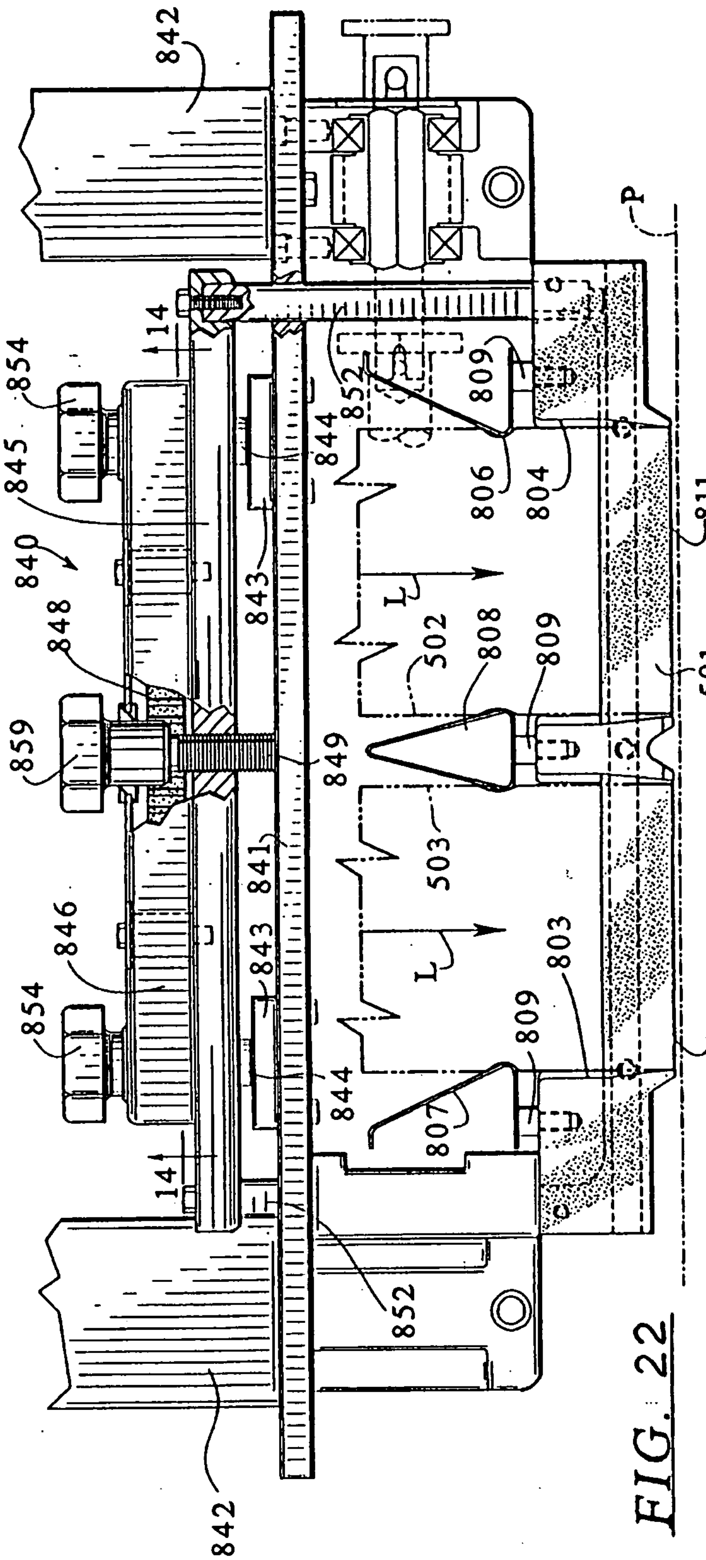

840
847
844
848
849
846
847
844

FIG. 23


842
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840
848
859
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846
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843
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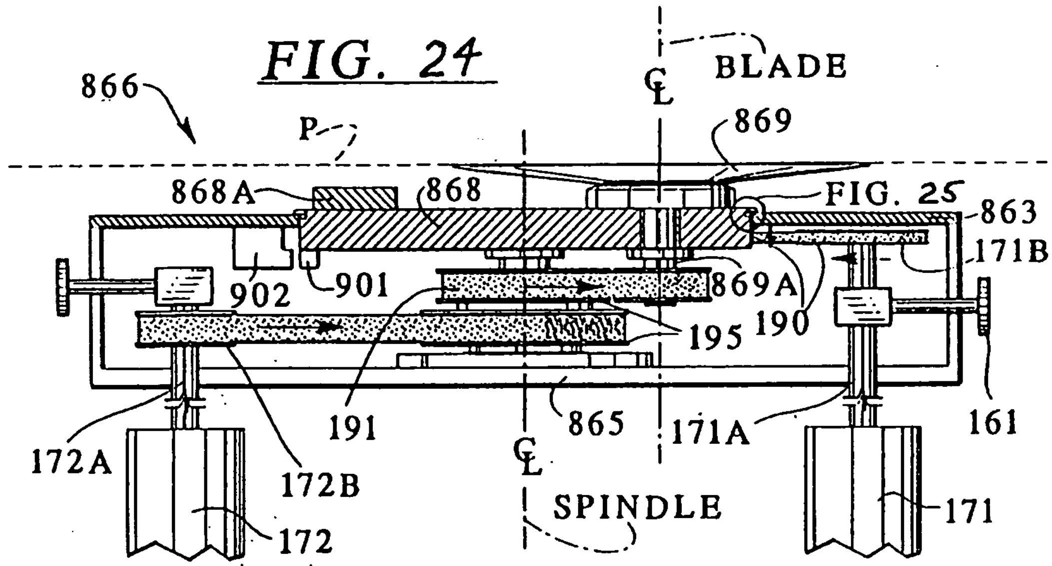
809
503
L
803
809
807
811
501
811
P

FIG. 22

FIG. 24



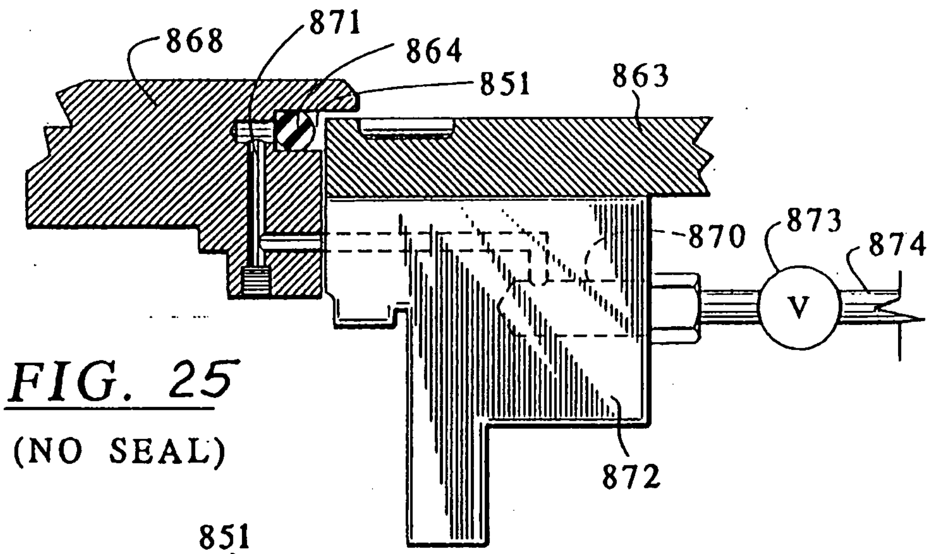


FIG. 25
(NO SEAL)

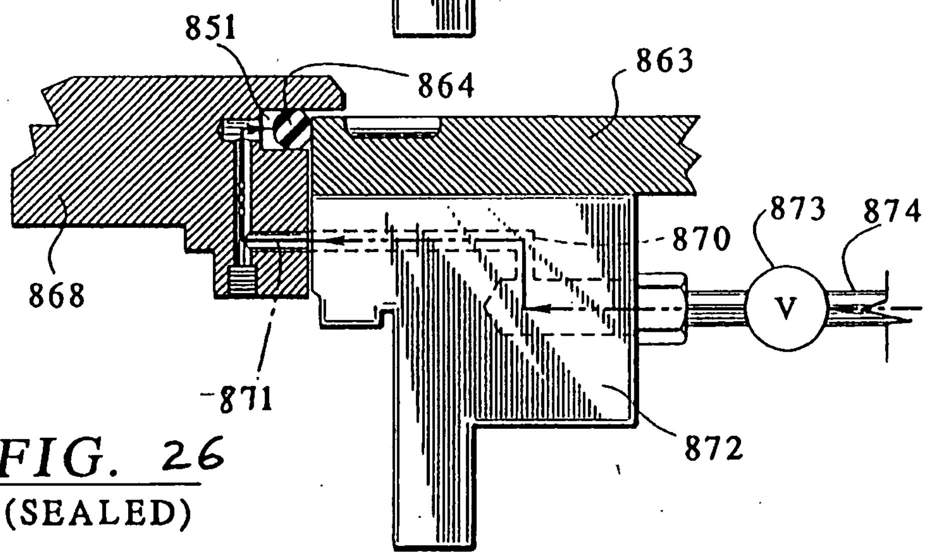
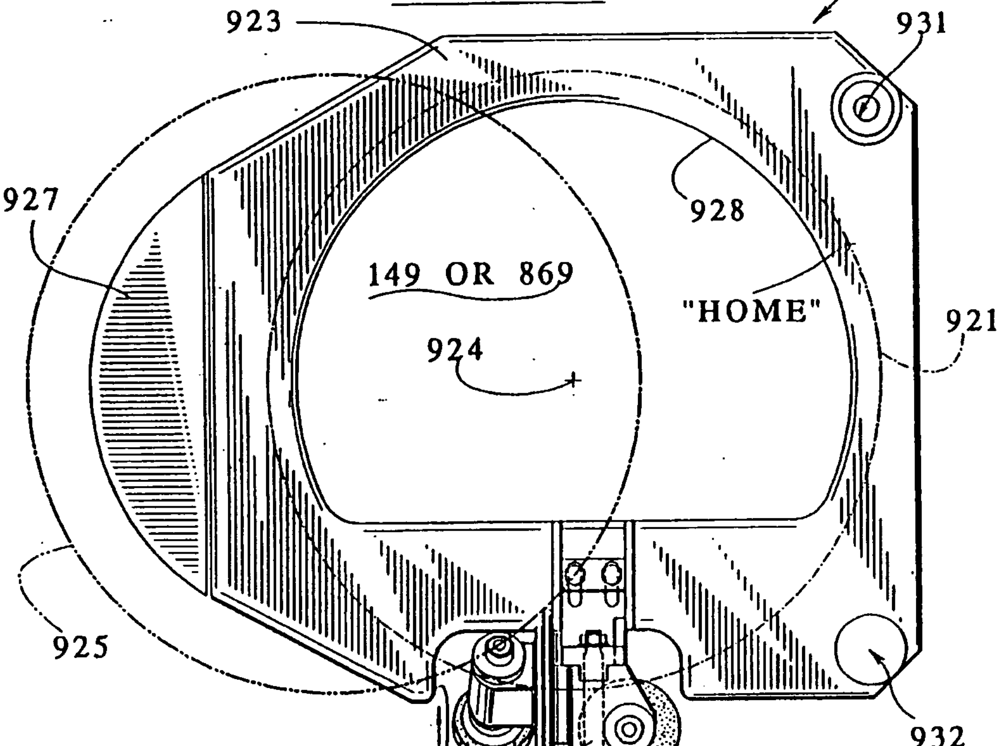


FIG. 26
(SEALED)

FIG. 27



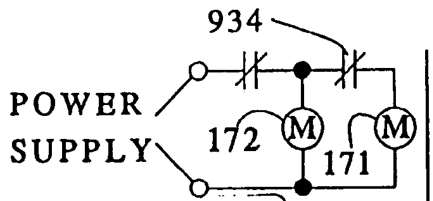
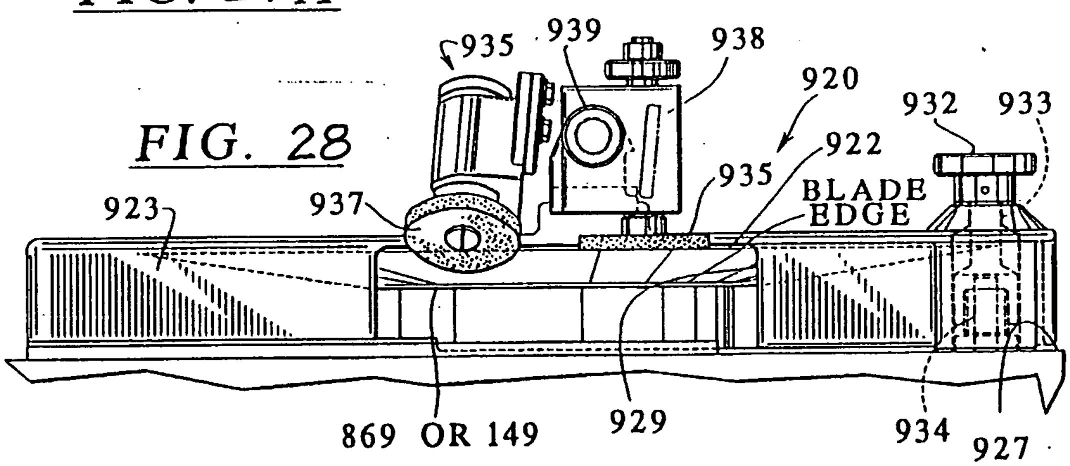


FIG. 27A

FIG. 28



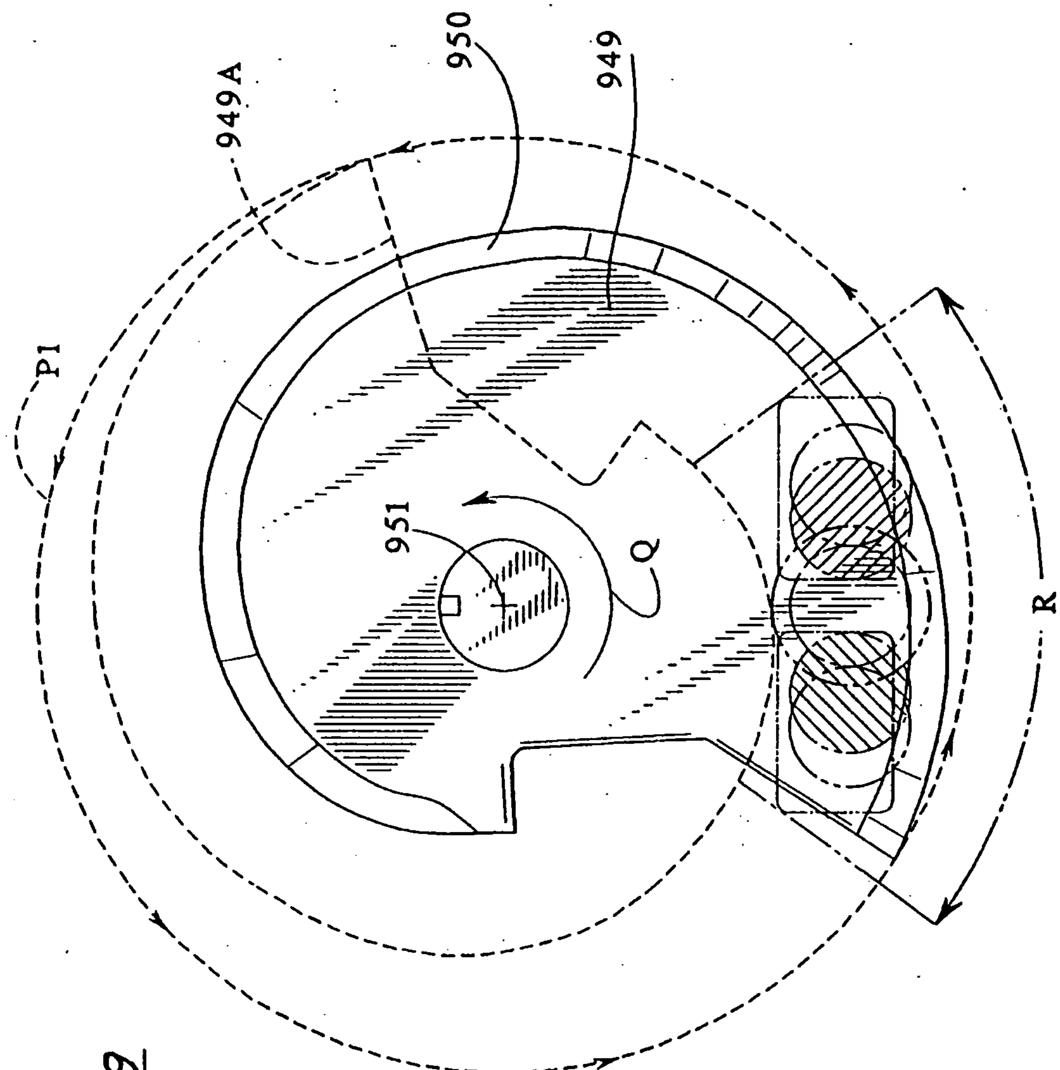
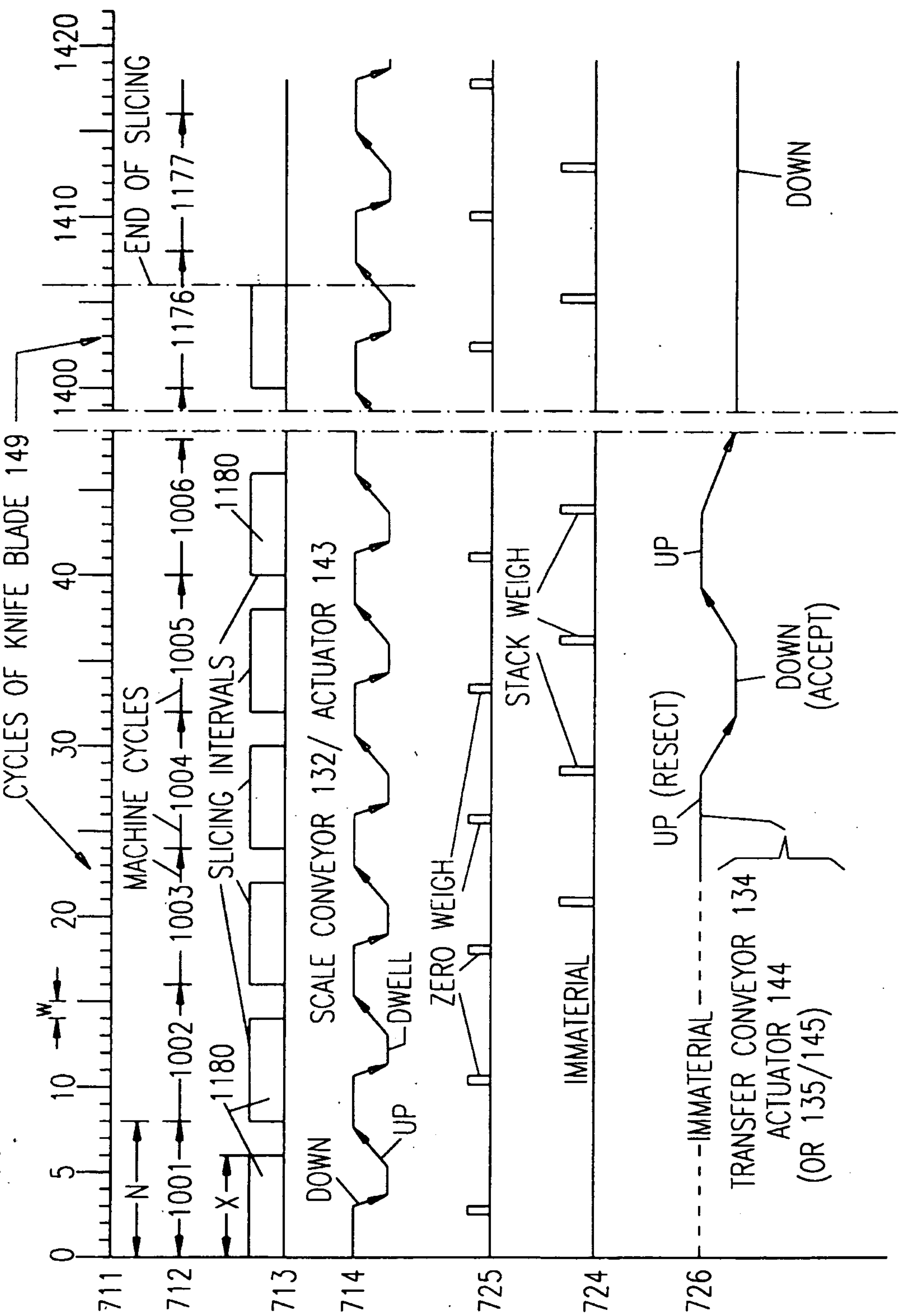


FIG. 29

FIG.30


CYCLES OF KNIFE BLADE 149
MACHINE CYCLES
SLICING INTERVALS
END OF SLICING
SCALE CONVEYOR 132/ ACTUATOR 143
DOWN
UP
DWELL
ZERO WEIGH
STACK WEIGH
IMMATERIAL
UP (RESECT)
UP
DOWN (ACCEPT)
DOWN
TRANSFER CONVEYOR 134
ACTUATOR 144
(OR 135/145)
N
X
W
1001
1002
1003
1004
1005
1006
1176
1177
1180
0
5
10
20
30
40
1400
1410
1420
711
712
713
714
725
724
726

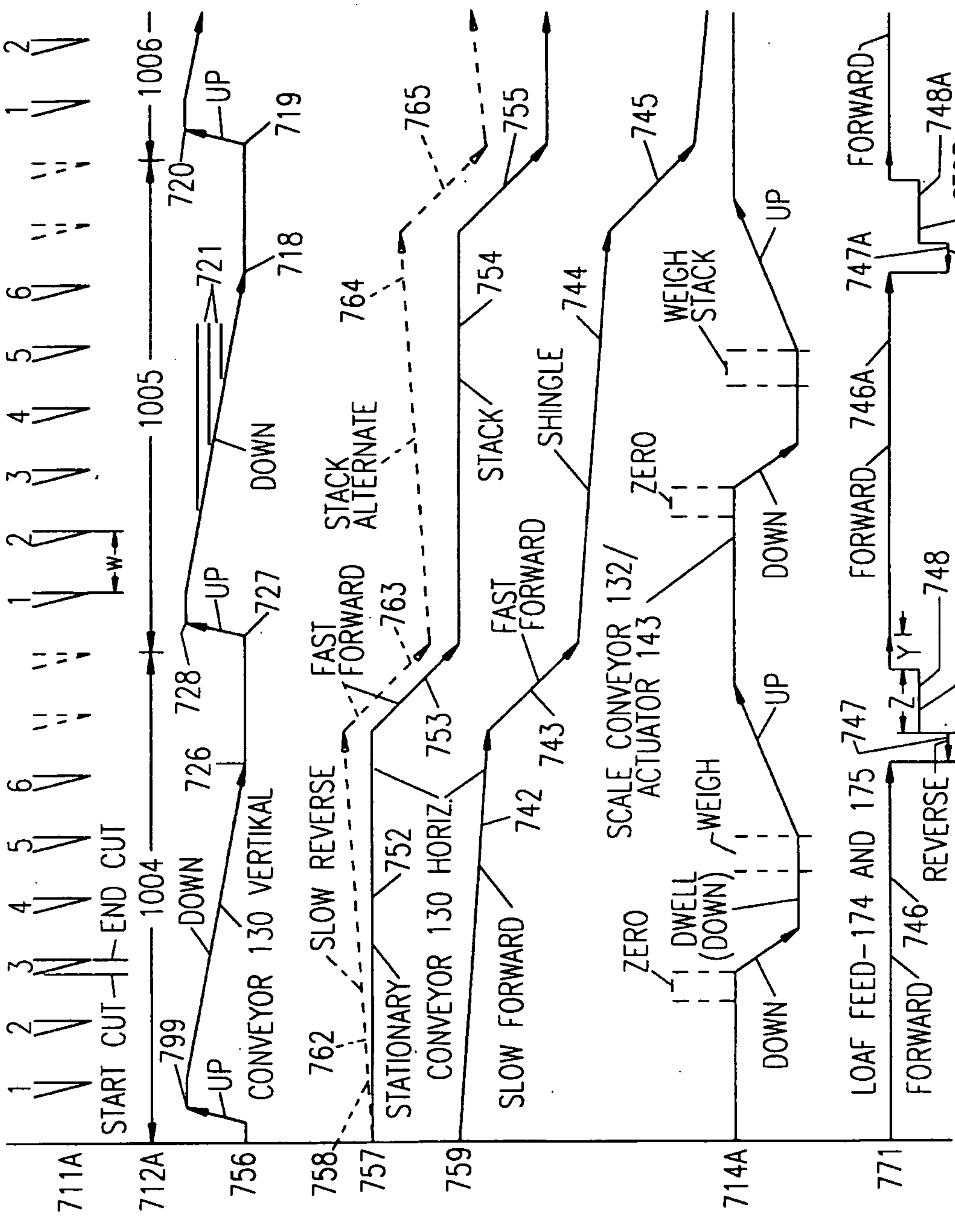

711A
712A
756
758
757
759
714A
771
START CUT
END CUT
1004
1005
1006
W
UP
DOWN
CONVEYOR 130 VERTIKAL
799
726
727
728
720
719
718
721
762
SLOW REVERSE
STATIONARY
CONVEYOR 130 HORIZ.
752
753
FAST FORWARD
763
STACK ALTERNATE
764
765
754
755
STACK
SLOW FORWARD
742
743
744
745
SHINGLE
SCALE CONVEYOR 132/ ACTUATOR 143
ZERO
DWELL (DOWN)
WEIGH
WEIGH STACK
LOAF FEED-174 AND 175
FORWARD
REVERSE
STOP
746
746A
747
747A
748
748A
Y
Z

FIG.31